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The 155 MPH Electric SUV

HOW IT WORKS

WE TEAR OPEN 8 AMAZING MACHINES

P.47

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The Fighter Jet That Stops in Mid-Air

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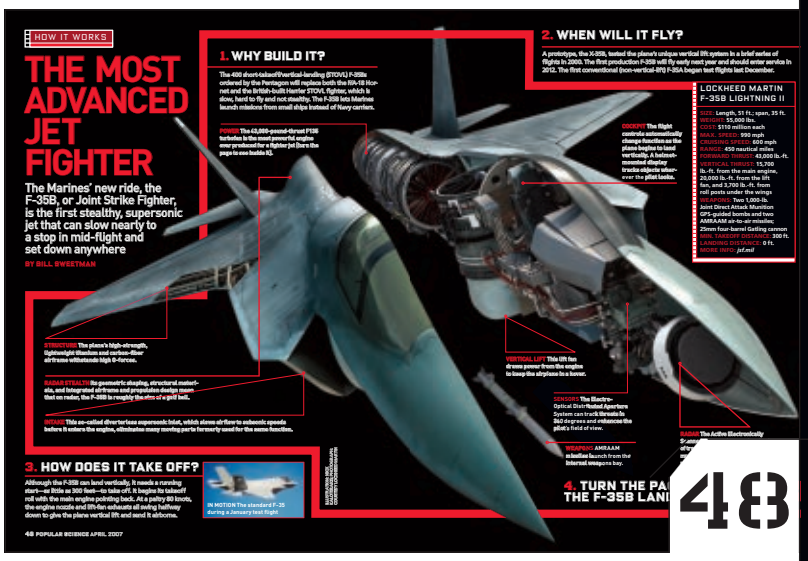
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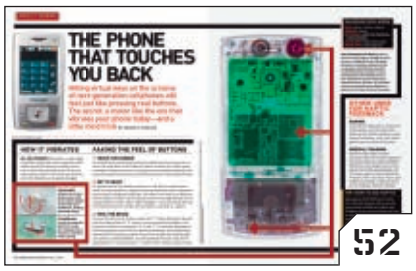
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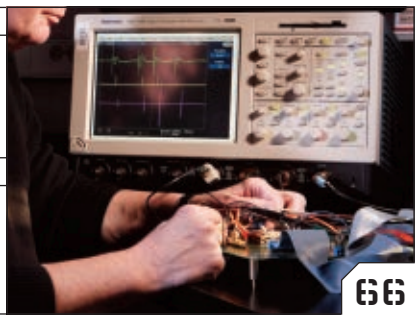






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Neuroscientist Ted Berger sees the brain as a giant computer—and he thinks he knows how to upgrade it. **By Stephen Handelman**



UNCOMMON KNOWLEDGE

72 STUDIES SUGGEST HEADLINES ARE BAD FOR YOU Red wine stops aging? Chocolate beats broccoli? Don't go on a binge until you find out what's *really* behind health claims. **By Jason Daley**



COVER: COURTESY ZAP (SUV); NICK KALOTERAKIS (PLANE); NYU/EMILIO VEGA USING SIEMENS DIGITAL RADIOGRAPHY (PHONE); THIS PAGE, BOTTOM ROW, FROM LEFT: JOHN B. CARNETT; COURTESY LUCASFILM

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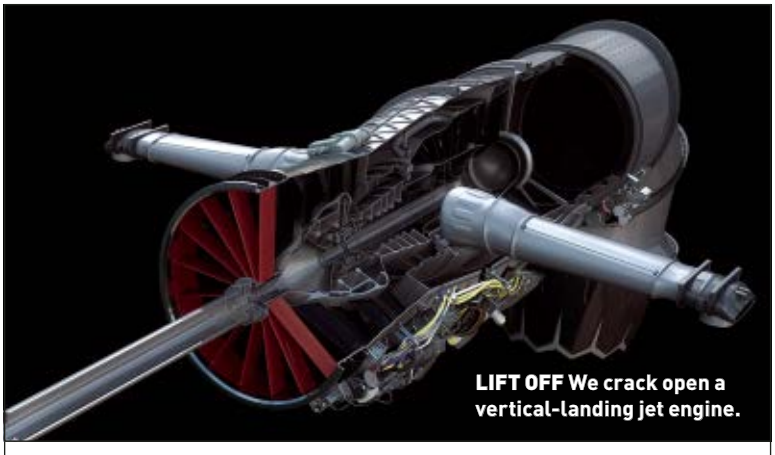
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THE FUTURE EVERY DAY

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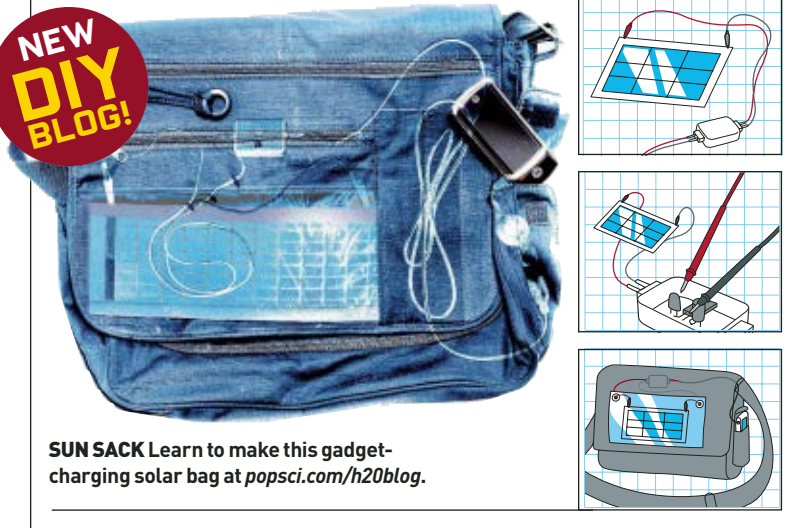
LIFT OFF We crack open a vertical-landing jet engine.

TAKE STUFF APART

One of our favorite activities at POPULAR SCIENCE is breaking things open to see what's inside. This month we're popping the hood on all kinds of gadgets, planes—even a gun—to get a closer look at how they work. Visit *popsci.com/howitworks* for animated views of the technologies featured in this issue, and many others. PLUS: Find out what makes Porsche's $150,000 watch tick, and learn how Indy cars stay glued to the track at 230 mph.

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NEW DIY BLOG!



SUN SACK Learn to make this gadget-charging solar bag at *popsci.com/h20blog*.

PUT STUFF TOGETHER

Introducing the new, improved How 2.0 blog, *popsci.com*'s latest community feature. This month we join forces with *Instructables.com*, our favorite user-generated DIY site, to bring you more projects, hacks and geek-tastic experiments than ever before. Submit your own ideas and find out what other readers are making at *popsci.com/h20blog*.

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CLOCKWISE FROM TOP LEFT: LUIS BRUNO (GOLF CLUB); NICK KALOTERAKIS; JASON LEE (3); PHOTOGRAPH: LUIS BRUNO; ILLUSTRATION: LEONELLO CALVETTI; COURTESY ROCKETPLANE KISTLER, INC.



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Constructive Destruction

ONE THING POPULAR SCIENCE READERS love to do is get to the bottom of things, to understand how things work. And here is a measure of the lengths we'll go to give you what you love: Last November, at the pre-holiday, pre-launch height of the PS3-vs.-Wii videogame frenzy, we took our precious pre-release Nintendo Wii console—and destroyed it.

It should be said that we did not intend to destroy it (though whether that absolves or intensifies our sin I'm not sure). As part of the research and photography for the second annual How It Works issue that you hold in your hands, we set out to take the Wii apart and lay its secrets bare. That we were in a rush and didn't have quite the right tools and approached the task in a less subtle manner than we would certainly advise others to do, well . . . I don't mean to excuse our actions. I do, however, want to commend what associate Web editor John Mahoney decided to do next: He took the autopsy photos of our disassembled, never-to-be-played-again Wii and posted them on *popsci.com*. And the crowd went wild. The "Wii Broke It" photo gallery garnered 1.7 million page views, making it our fourth most popular online feature in all of 2006.

"Last November we took our pre-release Nintendo Wii console—and destroyed it."

"Popular," in some cases, is perhaps not the right word. We got a well-earned helping of "any fool can smash and break things"-type chiding. But I was gratified to see, in perusing the dozens of comments on the site, that curiosity ultimately trumped curmudgeon, that responses of "Shame on you, PopSci" were outnumbered by those of "Sometimes the only way you learn is by just diving right in" and "Hey, the GPU is bigger than the CPU. That's interesting." Because even if I'm not thrilled that we destroyed a Wii to reveal and document its mechanisms, I *am* happy that we were motivated by a classically PopSci urge to know—and to tell. And I think you'll agree that the intel in the How It Works package that senior editor Mike Haney and his team have delivered, beginning on page 47, is worth any number of disemboweled videogame consoles.



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JOHN B. CARNETT



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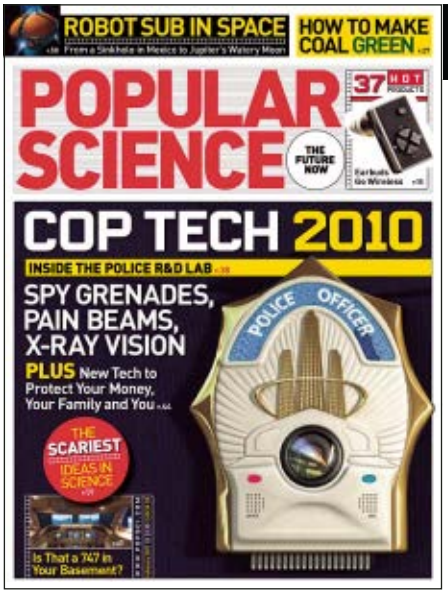


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Star Power

It really is too bad that there aren't more people like Bill Stone and Burt Rutan around ["Journey from the Center of the Earth," February]. Leave it to the for-profit people to take down the cost of space business yet keep the technology going forward. NASA certainly isn't doing that. The only thing the government should really do in regard to space is to hammer out the rules and regulations. NASA could just become a technical adviser, only when needed.

Mike Martinez
Hudson, Wisc.

Bright Idea

That was an awesome picture of the International Space Station against the sun ["Hot Shot," Megapixels, Feb.]. I noticed another black dot in the upper right-hand corner. Any idea what that might be?

Antonio Villanueva
Via e-mail

Photographer Thierry Legault replies: *It's a sunspot. We are currently in a period of low solar activity, so sunspots are not numerous. In fact, because we're nearing the minimum of the 11-year activity cycle, sometimes the sun appears without any spots at all. This single spot seems small, but it's almost half the size of Earth!*

FROM THE BLOGS

The February issue has a great article, "Officer Gadget," that looks at the cutting-edge technology that might enable police to work more safely and effectively. Video "grenades" that give 360-degree views, pain beams that do no permanent harm—these are the sorts of devices that are long overdue. The idea behind them is more effective apprehension and prevention with less deadly force. I don't see how anyone could argue with that.

Cliff Biggers
cliffbig.blogspot.com

"TOO BAD THERE AREN'T MORE PEOPLE LIKE BILL STONE."

Skimming the Surface

Although I enjoyed the article about Maritime Flight Dynamics's development and testing of the Sea Phantom watercraft ["Fly the Friendly Seas," Concepts & Prototypes, Feb.], the concept is certainly not revolutionary. Soviet manufacturers built and tested their "Ekranoplans" from the 1960s through the 1990s. Powered by either turbofans or turboprops, variants could not only skim a few meters above the water's surface at up to 200 miles an hour, but could travel up a beach and over solid terrain.

Hank Baltzersen
Cincinnati

Rethink Your Drink

In "Fighting Water Woes" ["Your Guide to the Year in Science: 2007," January], I think you missed the point of what I said about Pellegrino-like quality. The main idea is that desalination technology can now produce water of very high quality at an affordable price. Your final statement—"Indeed, the best solutions to the coming water crisis may be as mundane and varied as low-volume-flush toilets and drought-resistant crops, especially in the developing world, where funds for Pellegrino-spitting facilities are as scarce as water itself"—is naive. How can you expect water-saving measures to fix the water problems of the developing world, when many drought-plagued countries have no water to begin with?

Nikolay Voutchkov
Senior vice president, technical services, Poseidon Resources
Stamford, Conn.

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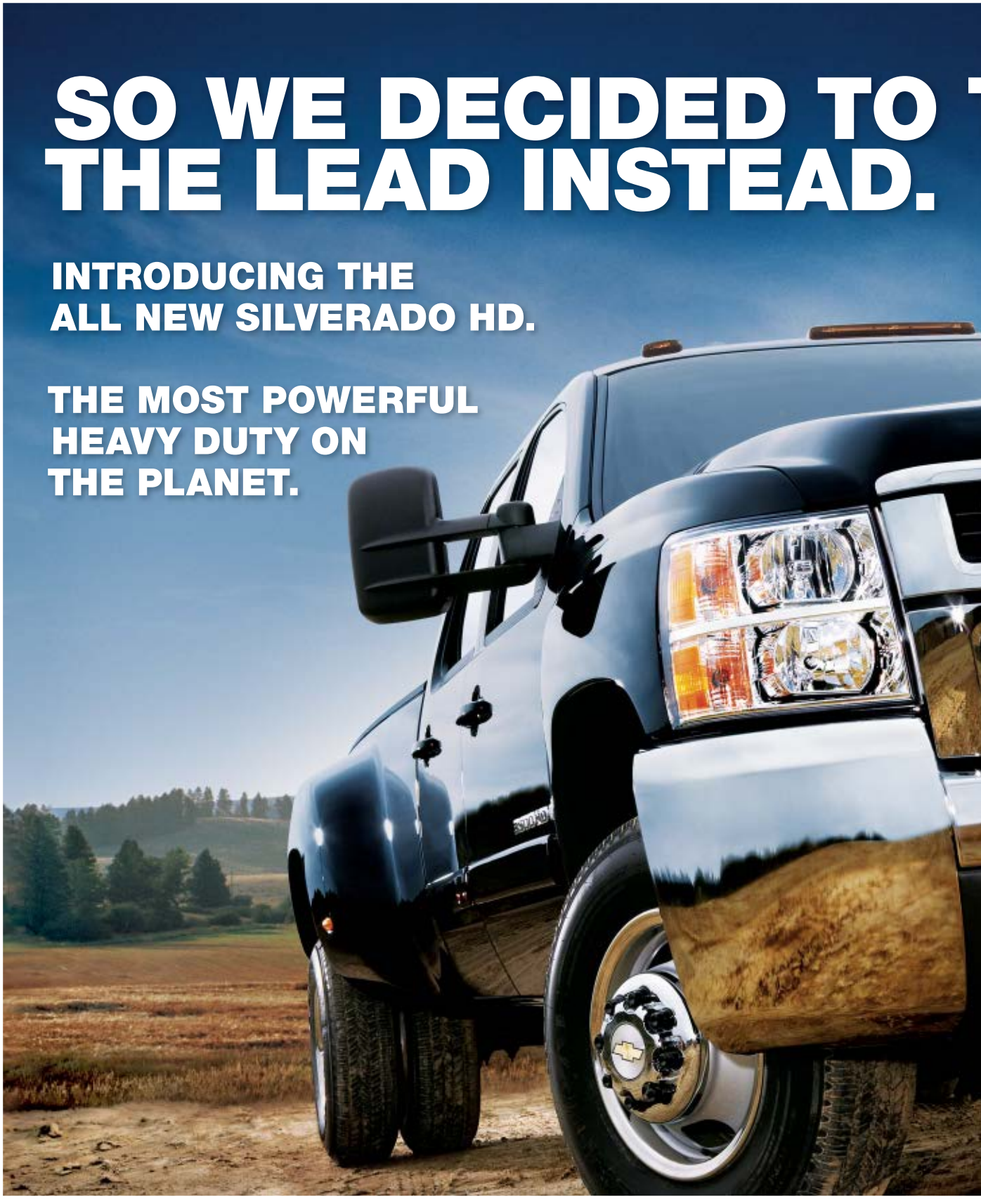
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MEGAPIXELS

THE MUST-SEE PHOTOS OF THE MONTH



MAX PLANCK INSTITUTE FOR INFECTION BIOLOGY

POPSCI ON THE WEB See more amazing photos at *popsci.com/gallery*.

BUG NETS

It's a fight to the death as human cells battle bacteria

On the front line of the nasty struggle between our immune system and foreign bacteria are neutrophils, the most abundant type of white blood cell. The crucial role that these cells play in destroying invading pathogens has been known for years, but only recently did scientists discover the secret weapon shown here: bacteria-trapping NETs—neutrophil extracellular traps—made of enzymes and DNA. Researchers at the Max Planck Institute for Infection Biology in Berlin have determined that NETs are catapulted out of dead or dying neutrophils to capture, disarm, and eventually kill bacteria [the orange organisms in this photo]. "To mobilize the DNA and extrude it to catch and kill microbes is a very powerful way to fulfill the neutrophils' protective role, even after their death," explains Volker Brinkmann, a study leader. Call them the body's kamikaze fighters.

BY KATHERINE RYDER PHOTOGRAPH BY VOLKER BRINKMANN





COURTESY FORSCHUNGSZENTRUM KARLSRUHE; INSET: MARTIN LOBER/ FORSCHUNGSZENTRUM KARLSRUHE

WIDE LOAD

After a 5,600-mile journey, a special delivery inches toward its new home

Citizens of the German town of Eggenstein-Leopoldshafen could be forgiven for peering out their windows last November and concluding that the world's largest beer keg was being paraded through the streets. Alas, the 200-ton barrel-like structure was actually a supersize spectrometer en route to the nearby city of Karlsruhe. There, it will play a crucial role in a joint European and American experiment called KATRIN, designed to measure the mass of a neutrino, the elusive "ghost particle" in abundance throughout the universe. Although the spectrometer was manufactured just 200 miles from its destination, it was too big to be transported on the highway and instead made a two-month journey down the Danube River to the Black Sea, across the Mediterranean, through the Strait of Gibraltar, north to the English Channel, up the Rhine River to Eggenstein-Leopoldshafen, and overland to Karlsruhe: a slow haul for a machine that will detect particles that normally move at nearly the speed of light. **BY KATHERINE RYDER**
PHOTOGRAPH BY MARKUS BREIG



GROUND CONTROL Technician Matthias Kirschner used remote controls to guide the spectrometer, which was secured to a flatbed, along the narrow village streets.

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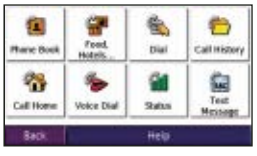
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WHAT'S NEW



22 Power your gadgets without wires



24 High-tech hiking and camping gear



26 Devices that deliver more video to your TV

TRIPLE THREAT



Go ahead, just try to wipe out on this backward electric trike

THREE WHEELS may not seem as sexy as two—unless you're carving hairpin turns at 60 mph on a slick road, without fear of unsexy road rash. Oh, and without burning a drop of gas.

The highway-legal Vectrix scooter's speed-sensitive steering and suspension keep both front wheels on the ground even when the rider leans deep into a turn, thanks to ball joints in the fork that let the wheels travel up and down more freely the faster the bike is going. Each wheel connects to the steering column through its own axle, but a series of rods syncs their movement so both lean at the same angle in a turn. When the trike slows, the suspension system locks the bike in an upright position so it's perfectly stable at a stop sign.

And, because the front wheel of a motorcycle is more likely to slip in a turn, adding another improves traction. The design also allows for more cargo or a canopy. Jim Plagenhoef, Vectrix's director of North American sales, envisions waves of meter-readers and mail carriers on the three-wheelers in rain, sleet and snow. The company plans to have 20 prototypes built by August and to start selling the scooters in the U.S. next year.—KYLE STOCK

▲ **The Vectrix's flexible front suspension lets it lean into a turn without losing grip.**

THE VECTRIX

COST: $12,000 (est.)
MAX. SPEED: 62 mph
RANGE: 2.5 hrs. at 25 mph
BATTERY: 120 volts
HORSEPOWER: 27
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COMING: 2008
MORE INFO: *vectrix.com*



COURTESY VECTRIX



REMOTE PATROL

Be your own housesitter. The Wi-Fi chip in this robot lets you maneuver it—and its webcam—from any Internet connection. If you catch Fido on the couch, yell "Off!" through the 'bot's built-in VoIP phone. **Erector Spyke $300; *erector-sets.com***

NOW TAKING REQUESTS

The Connect is the first MP3 player that lets you use built-in Wi-Fi to download songs from Yahoo, Napster and other major music sites. **SanDisk Sansa Connect $250; *sandisk.com***





RISE AND SHINE

Clean hard-to-reach spots—second-story windows, SUV roofs—with this battery-powered scrub brush, extendable up to 10 feet. Its wires hide inside interlocking fiberglass poles, which are sturdy yet light enough to lift overhead. **Black & Decker 18V Power Scrubber $100; *blackandecker.com***

CURSORY MOVEMENTS

Airplane trays don't leave much wiggle room, so Razer outfitted this mini wireless travel mouse with an ultra-high-resolution sensor. Nudge it an inch to push your cursor all the way across the screen. **Razer Pro|Click Mobile $60–$70; *razerpro.com***





DON'T DROP YOUR CALLS

Your conversations don't have to end because your cellphone headset died. A capacitor inside this one stores extra energy, so you can keep talking for 30 seconds while you change batteries. **Sennheiser BW900 $370; *sennheiser.com***

SMALL IMPACT

Impact drivers produce more torque than regular power drills, so they turn large bolts more easily. This 2.2-pounder—the lightest ever made—is easier on the arm: With a lightweight, high-power battery, it's half the size of similar tools. **Bosch Litheon 10.8V Impactor $200; *boschtools.com***



THE GOODS

12 MUST-HAVE PRODUCTS

BY LAUREN AARONSON

RADIO WAVES

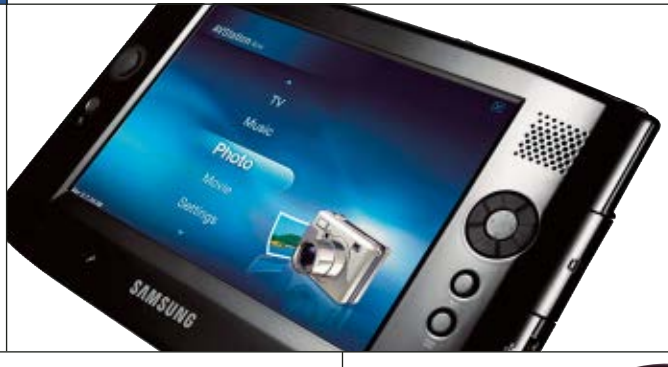
A marine VHF radio doesn't do you much good at the bottom of the ocean, so this one floats. A watertight seal traps air in the spaces around the extra-small internal components, creating a buoyant bubble. **Icom M34 $170; *icomamerica.com***





MP3-JAY

Aspiring music producers and DJs now have a completely portable recording studio. This mixer lets you create four-track masterpieces, fades and all, and save the results straight to an iPod. **Belkin TuneStudio $200–$250; *belkin.com***



FLASH-FORWARD

One simple change makes this ultra-mobile PC quicker, more energy-efficient and less prone to malfunction than others: Samsung replaced the traditional hard drive with 32 gigabytes of speedy, reliable flash memory. **Samsung Q1P SSD $2,000; *samsung.com***



TRAP MAPPER

Next time you pass a state trooper, mark the spot on this radar detector. A GPS chip inside alerts you when you near the area again. Flag chronic false-alert locales, and stray beeps disappear. **Escort Passport 9500i $450; *www.escortradar.com***

GET THE SHOW ON THE ROAD

Watch HBO anywhere you go. The first portable satellite TV looks like a briefcase but opens up to reveal a 17-inch LCD. The antenna, no longer a dish, unfolds from the top cover. **DIRECTV Sat-Go Price not set; *directv.com***





IT'S HIP TO BE SQUARE

Can't fix that slice? The square shape of this driver distributes weight evenly—and makes for a more forgiving, straighter-shooting club. **Callaway Golf FT-i Driver $625; *callawaygolf.com***





A lockable In-Bed Trunk.™ A dual-action tailgate. And the highest government crash-test rating.* Solid proof the Ridgeline is perfectly designed to tackle your next urban adventure.

*Based on National Highway Traffic Safety Administration frontal- and side-impact crash tests, April 2005. ©2006 American Honda Motor Co., Inc.

Built for the urban wild.



THE RIDGELINE HONDA

TESTED

SMART SURFERS

Many cellphones connect to the Web. Using these two systems makes it enjoyable

THE PROBLEM WITH USING the Internet on your mobile phone is that the Internet was not made for your mobile phone. Web pages are usually 800 pixels wide (you've got an awesome handset if its screen is half that size), and they're packed with bandwidth-hungry graphics and animations that bog down all but the fastest connections. The best cellphones for surfing the Web have operating systems that are selective about accessing data, downloading only what you need and displaying it neatly on small screens. We tried two new phone systems to see how they sped up the mobile Web.—JOE BROWN



9

SYSTEM: SERIES 60, THIRD EDITION

TESTED ON: Nokia N80 Internet Edition ($500; *nokia.com*)

AVAILABLE ON: Nokia E- and N-Series phones

WHAT IT DOES: A dedicated search program lets you query Google or Yahoo without opening a Web browser, and the included open-source browser loads only the section of page visible on the phone's screen. Upload photos snapped with the three-megapixel camera directly to your Flickr account.

THE VERDICT: Flawless. The N80 uses the slowish EDGE data network, but we barely noticed. E-mail fetched just the message headers first to save time, and the search function spared us Google ads and the like. For heavier surf sessions, the phone has built-in Wi-Fi.



7

SYSTEM: CELLTOP

TESTED ON: Samsung SCH-u520 ($50 with contract; *alltelwireless.com*)

ALSO AVAILABLE ON: LG AX245, Motorola Razr V3m, Samsung SCH-u420

WHAT IT DOES: CellTop lets you access oft-viewed content without opening a browser. Half-screen windows ("cells") contain sports scores, stocks, weather, headlines and more—continuously updated over the high-speed EV-DO network.

THE VERDICT: We could quickly browse through the cells and click the "OK" button for more detail. But we were frustrated by the sparse initial offerings. More cells are in the works, though, including common e-mail services and a menu of podcasts. (Please, oh please, make a Google cell!)

SATOSHI



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*Resolution comparison based on 480i vs. 1080i pixel counts. © 2007 North American HD DVD Promotional Group, Inc.

COMING SOON

CUTTING THE LAST CORD

Two new technologies let you wirelessly charge your gadgets

IS A CELLPHONE really "wireless" if you have to plug it in every day? And how far can you roam with a laptop if you're dragging a power cable behind you? Several companies recently unveiled technologies that finally untether your gadgets and deliver juice through the air. Here are two promising candidates.—ANDREW BRANDT



SENDING POWER OVER RADIO WAVES

Powercast's system delivers one to two watts of power over 915-megahertz radio waves using a transmitter embedded in an unobtrusive object—say, a lamp [as shown in this prototype]. A coin-size receiver either built into your device or attached with an adapter and placed within about 10 feet of the transmitter converts the waves into a few milliwatts of electricity—sufficient to charge your phone or camera in your pocket. (In theory, the receivers could pull additional energy from ambient radio-wave sources such as TV broadcasts.) Philips plans to release several products with Powercast's technology by year's end, including LED candles and Christmas lights. ***powercast.com***

CHARGING UP CLOSE

Devices that are charged by induction (drawing electricity from an electromagnetic field), like electric toothbrushes, can typically pull a watt of power at most. But later this year, Visteon will introduce the first induction device [right] that can charge cellphones and MP3 players. (It will require adapters, but receivers could be built into gadgets.) The secret: induction coils, made by eCoupled, that can deliver several thousand watts efficiently and safely by constantly measuring how much power a nearby device requires and adjusting output. A coil embedded under a countertop could power an iPod or a toaster without harming bystanders. ***ecoupled.com***



IN RELATED NEWS . . .

ALTHOUGH YOU CAN'T yet power your TV wirelessly, you can lose the rest of the cords. Wireless HDMI, from Tzero and Philips, uses ultra-wideband radio waves to transmit audio and uncompressed high-definition video about 25 feet at three gigabits per second. That's enough for 1080p, the highest-definition format, used in Blu-ray and HD-DVD movies. The Philips Wireless HDMI transmitter-receiver pair shown here will sell in late summer for about $400 (not much more than an extra-long HDMI cable). Attach one to your cable box or DVD player and the other to the back of your set. A competing system, Wireless High Definition Interface, uses specially tuned Wi-Fi and can send 1080p video at least 100 feet. That technology will appear in Sanyo projectors late this year.



ILLUSTRATIONS: PAUL WOOTTON, ITZHACK SHELOMI; PHOTOGRAPHS: SATOSHI

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FULLY LOADED

THE CALL OF THE WIRED

Be the envy of the outdoors with gear that keeps you dry, safe and powered up

1. KENSINGTON FX 500 SPEAKER TO GO

A rugged set of iPod speakers, encased in vinyl and foam, survives splashes and falls. **$50; *us.kensington.com***

2. KESTREL 4500 WEATHER METER

Know which way the wind blows with a meter that shows both gust speed and, with its digital compass, direction. Attention, meteorology geeks: It stores up to 2,000 measurements, including humidity, temperature and pressure, that you can upload to your PC. **$400; *nkhome.com***

3. MSR REACTOR STOVE SYSTEM

This stove won't blow out in high winds because it premixes air and fuel and doesn't require open air at the burner. As the fuel canister empties, a built-in regulator maintains consistent gas pressure, and thus a consistent—and quick—boiling time of three minutes per quart. **$140; *msrgear.com***

4. OLYMPUS 770 SW CAMERA

This impact- and crush-resistant digicam works under water up to 33 feet deep and tags pics with the depth and pressure at which they were snapped. Outside the water, droplets won't stick to the lens. An LED illuminates close-up shots and doubles as a flashlight. **$380; *olympusamerica.com***

5. GREGORY Z30 PACK

Save your joints: This daypack adjusts its frame depending on how much you carry. The heavier your load gets, the more the weight pulls on two criss-crossed, flexible steel rods on the back. As the rods tense, they provide more support and distribute weight evenly. **$120; *gregorypacks.com***

6. BUSHNELL ONIX 400 GPS RECEIVER

Real-time weather fronts roll across maps on this handheld GPS unit, the first with Doppler-radar feeds from XM satellite radio, plus XM's music and sports. The display also layers trail routes on top of aerial photos, satellite images and topographic maps. **$500; *bushnellgps.com***

7. SPECIALIZED S-WORKS EPIC CARBON DISC

This ultralight mountain bike instantly adapts to trail conditions. Fast-flowing compression fluid lets the rear shock automatically switch between a cushy, loose suspension for passing over rocks in comfort and a stiff, fast mode for zooming across flat spots at top speed. **$6,500; *specialized.com***

8. KORKERS GUIDE WADING BOOT

Interchangeable soles offer the best grip for your terrain, whether it's rubber lugs for streamside hikes or felt for slippery boulders. Just snap one of six soles (two included) onto tongue-and-groove locks on the shoe's underside. A lacing system borrowed from snowboard boots lets you dial in a snug fit. **$160; *korkers.com***

9. MOUNTAIN HARDWEAR STIMULUS JACKET

To make the lightest waterproof jacket around—a mere five ounces—Mountain Hardwear adhered a polyurethane laminate to a near-weightless tricot mesh. **$175; *mountainhardwear.com***

10. PULSE BARRYVOX AVALANCHE TRANSCEIVER

Climbing Mt. Everest? The accelerometer in this rescue beacon detects the subtle movements that indicate you're still breathing, and the device radios your health status and location to rescuers. **$400; *mammutusa.com***—MARK ANDERS



THIS PAGE, CLOCKWISE FROM TOP LEFT: COURTESY KENSINGTON; COURTESY MOUNTAIN SAFETY RESEARCH; COURTESY GREGORY MOUNTAIN PRODUCTS; COURTESY BUSHNELL; COURTESY OLYMPUS; COURTESY NIELSEN-KELLERMAN; FACING PAGE: ILLUSTRATION: PAUL WOOTTON; PHOTOGRAPH: JOHN B. CARNETT; INSET: COURTESY EUREKA

11. EUREKA N!ERGY 1310 TENT

You can see in the dark with the first electric tent, but you can't see the wires—they're built-in and hidden under fabric sleeves. Power flows from an eight-pound, detachable, 12-volt DC battery that charges from your car. Plug lamps, cellphones—anything with a 12-volt adapter—into the tent's three glowing sockets. **$300; *eurekatent.com***



OUTDOORS OUTLET Plugs inside the tent deliver up to 18 hours of electricity.

TECH TREND

THE OTHER CABLE TV

New Internet video services provide more options for demanding couch potatoes

THE TREND

Video delivered directly to your TV screen over high-speed Internet through a dedicated set-top box. A few devices have been providing niche video this way, but new entrants like Sony and Apple could bring more mainstream offerings.

WHY NOW

With broadband connections in most homes and the explosion of interest in homemade video, the time is ripe to move new viewing options from the sit-and-click computer to the turn on, tune in, zone out TV environment.

HOW YOU'LL BENEFIT

The only thing better than TV is more TV. Cable can send only so many channels down the wire. But, like the Web itself, Internet TV options are virtually limitless. An all–Christopher Walken channel? No problem.—STEVE MORGENSTERN



THE iTUNES CONNECTION

Apple TV doesn't completely free you from your computer, but it brings a huge source of popular TV shows and movies—the iTunes store—to your living room. Think of the box as a pipeline pumping your iTunes library (Mac or PC; music, photos and video) to your TV. Apple has been characteristically secretive about the final features, but we know it will give you the option of connecting to your computer by Ethernet or next-gen 802.11n Wi-Fi, will buffer content on its internal 40-gigabyte hard drive rather than stream it (for smoother playback), and will support high-definition video. **Apple TV $300; *apple.com***





THE WEB-READY TV

Starting this summer, Sony will deliver free Internet video through an optional box mounted on the back of its high-end Bravia sets. Announced pickings are slim—mostly video from AOL, Yahoo and Grouper, plus movie trailers and music videos—but the entertainment giant could expand its offerings if the service is a hit. Although the adapter has no storage, Sony says the box can stream HD content live without hiccups. **Sony Bravia Internet TV Price not set; *sony.com***

THE EVERYTHING BOX

Digeo, a software supplier for cable boxes, unveils its own device later this year, combining high-def cable TV with broadband programming. The box has a digital video recorder and can play back CDs, DVDs, music files and photos, and it connects to receivers over coaxial cable to stream HD video from one set to another. **Moxi Multi-Room HD DMR About $1,000; *moxi.com***



CLOCKWISE FROM TOP LEFT: COURTESY APPLE; COURTESY SONY; COURTESY AOL (INSET); COURTESY DIGEO; COURTESY APPLE

Want to spend more time having fun, and less time looking for a bathroom?

FLOMAX may improve male urinary symptoms due to BPH in **1 WEEK.**



Talk to your doctor. For many men, FLOMAX may help in one week.

FLOMAX is approved to treat male urinary symptoms due to BPH, also called enlarged prostate. Only your doctor can tell if your symptoms are due to BPH and not another condition such as prostate cancer. Common side effects are runny nose, dizziness and decrease in semen. A sudden decrease in blood pressure may occur upon standing, rarely resulting in fainting. So avoid situations where injury could result. If considering cataract surgery, tell your eye surgeon you've taken FLOMAX. **To learn more, call 866-432-9734 or visit 4FLOMAX.com.**

If you can't afford FLOMAX, our Patient Assistance Program may help. Call 800-556-8317.

FLOMAX®
TAMSULOSIN HCl CAPSULES 0.4 MG

The 1-week difference.

Please see Patient Information on adjacent page.

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FLOMAX®
TAMSULOSIN HCl CAPSULES 0.4 MG

IMPORTANT PATIENT INFORMATION

What is FLOMAX?
FLOMAX is a prescription medication that is specifically designed to help relieve the signs and symptoms of *benign prostatic hyperplasia (BPH)*, a condition your physician may refer to as an enlarged prostate. FLOMAX works by relaxing the prostate muscles around the urethra, allowing urine to flow more freely out of the bladder. FLOMAX is NOT indicated for the treatment of high blood pressure.

Who should not use FLOMAX?
You should not take FLOMAX if you are allergic to tamsulosin hydrochloride or any other component of FLOMAX.

What should I be aware of before taking FLOMAX?
- An enlarged prostate (BPH) and cancer of the prostate cause many of the same symptoms. It is important that you see your doctor first to rule out prostate cancer.
- Though extremely rare, FLOMAX and other drugs in this class (alpha-1 blockers) have been associated with prolonged painful erection (priapism), which is unrelieved by sex. If this occurs, seek immediate medical attention, since this condition can lead to permanent inability to have an erection, if left untreated.
- During cataract surgery, a condition known as intraoperative floppy iris syndrome (IFIS) has been observed in patients treated with drugs in this class. When considering cataract surgery, inform your surgeon if you are taking or have taken FLOMAX and/or other drugs in this class.
- If you have had a serious reaction to sulfa, be sure to tell your doctor before taking FLOMAX.
- FLOMAX should NOT be used in combination with other drugs in its class since interactions may be expected.
- FLOMAX should be used with caution in combination with cimetidine or with warfarin (a drug often prescribed under the brand name Coumadin® [Bristol-Myers Squibb Company]).

Are there any warnings associated with the use of FLOMAX?
FLOMAX may cause a sudden drop in blood pressure, especially following the first dose or when changing doses. Although rare, this drop in blood pressure may be associated with fainting, lightheadedness or dizziness. Caution should be exercised when driving, operating machinery, or performing hazardous tasks, since injury could result.

What are the most common side effects of FLOMAX?
The most common side effects are dizziness, runny nose, and a decrease in semen. Other side effects include headache and tiredness.

How should I take FLOMAX?
FLOMAX 0.4 mg capsules are taken once daily. FLOMAX should be taken approximately one-half hour after the same meal each day. If you stop or forget to take FLOMAX for several days, start again with the 0.4 mg once-daily dose. If you were previously on a higher dose, contact your doctor before returning to the higher dose.

Do not crush, chew, or open FLOMAX capsules.

What about overdosing with FLOMAX?
You should always take your medications according to the directions given by your doctor. If you think you have taken an overdosage of FLOMAX capsules, contact your doctor immediately.

Still have questions?
For more information, ask your doctor or pharmacist, call 1-866-432-9734, and/or visit www.4FLOMAX.com.

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WHAT'S NEXT

DEEP STORAGE

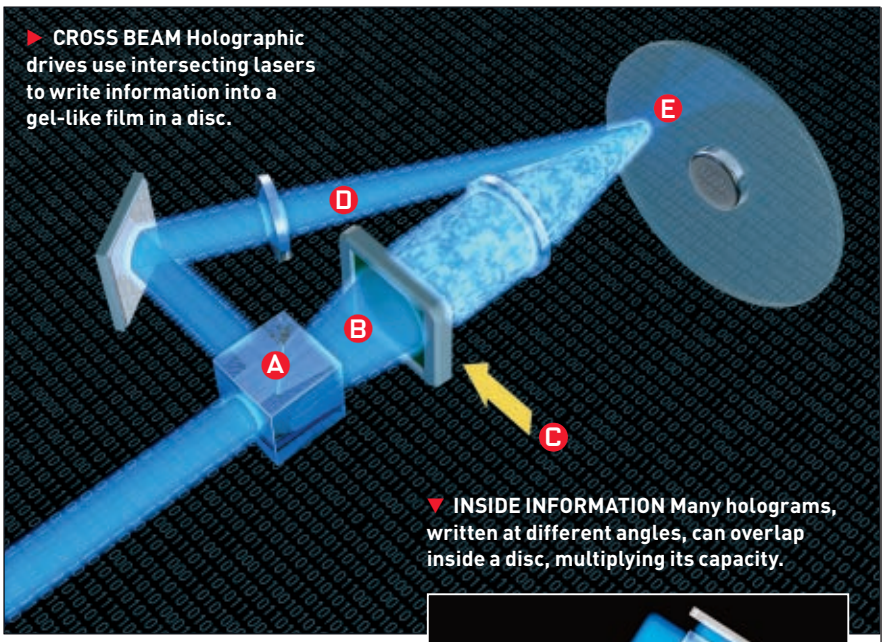
Holographic drives can archive dozens of high-def movies or a monstrous music collection on a single disc



SO BLU-RAY DVDS can hold 50 gigabytes? Big deal. A holographic disc can store *30 times* as much data. Stuck in the lab for decades, the mother of all memory is finally available, thanks to a gel-like film developed by InPhase Technologies. Whereas a DVD holds information on its surface and on a layer below its surface, a holographic disc packs data throughout the gel at every point where two laser beams cross. And it's fast: A single laser pulse etches one million bits, for a write speed nearly four times that of Blu-ray disc drives. Plus, the new gel is durable enough to last at least 50 years. The first commercial product, Maxell's 300-gigabyte discs, are meant for professional archiving, such as TV stations need. Expect consumer versions in two to three years. By 2010, discs will hold 1.6 terabytes and may eventually reach 100 terabytes.—LAUREN AARONSON

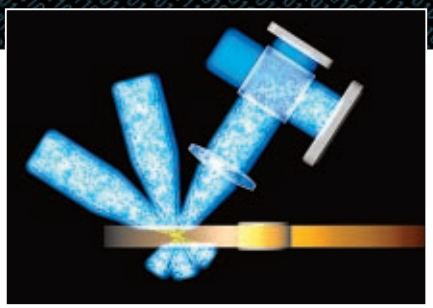
HOW IT WORKS

Holographic drives record information onto discs with blue lasers similar to Blu-ray, but first they use a **beam splitter [A]** to send the light in two directions. One part, the **signal beam [B]**, passes through a series of **micromirrors [C]**, which deflect certain sections of the laser, turning it into a checkerboard pattern of dark and bright pixels representing the 0s and 1s, respectively, of the data you're saving. When that beam intersects with the other half of the laser, the **reference beam [D]**, the overlapping light waves react with the light-sensitive gel to burn a 3-D pattern, or hologram, onto a **disc [E]**. Adjusting the mirrors changes the intersection, so holograms can overlap at different angles, packing more bits into one area.



▶ **CROSS BEAM** Holographic drives use intersecting lasers to write information into a gel-like film in a disc.

▼ **INSIDE INFORMATION** Many holograms, written at different angles, can overlap inside a disc, multiplying its capacity.

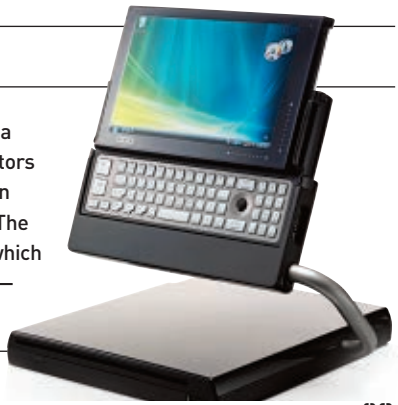


DATA DISC	CAPACITY	WRITING SPEED	WHAT FITS
HOLOGRAPHIC (2010 version)	1.6 TB	960 Mbit/sec.	400,000 songs
BLU-RAY	50 GB	36 Mbit/sec.	12,500 songs
HD-DVD	30 GB	36 Mbit/sec.	7,500 songs
DVD	8.5 GB	27 Mbit/sec.	2,375 songs
CD	0.7 GB	7.9 Mbit/sec.	175 songs

VERSION 2.0

POCKET PERFORMER

WHILE TREOS and iPhones cram partial computers into handhelds, OQO provides a full PC in a one-pound, portable, paperback-size case. Critics panned the anemic performance of the first OQO, released in 2004. But model 02 (starting at $1,500; *oqo.com*) packs up to a 1.5-gigahertz processor, a gigabyte of RAM and a 60-gigabyte hard disk. It can drive two monitors at 1080p high-def resolution, and it sports an always-on EV-DO cellular data connection. The minimalist docking station [shown here]—which provides a DVD burner and additional ports—makes an elegant pedestal.—SEÁN CAPTAIN



ILLUSTRATIONS: STEVE CROSS; PHOTOGRAPHS, FROM TOP: COURTESY INPHASE TECHNOLOGIES; SATOSHI



Back-UPS® ES 750 shown.
**Back-UPS® ES 550R sells for $59.99. See details below.*

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- Venture Development

Think of all that you rely on your computer for: personal and business files, financial information, broadband access, videos, photos, music, and more. Increasingly, computers are the hub for managing our lives. And more people rely on APC to protect their hardware and data than any other uninterruptible power supply (UPS) brand.

Why is APC the world's best selling power protection? For 20 years, we have pioneered power protection technology. Our Legendary Reliability® enables you to save your data, protect your hardware, and prevent downtime. It also guards against a power grid that is growing less reliable every day.

According to the Department of Energy, electricity consumption will increase by 40% over the next 10 years. Yet today, investment in utilities is at an all-time low. It's a "perfect storm" for computer users, one that makes APC protection even more essential.

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SPACE TOURISM

UP AND AWAY

In the latest bid to rocket tourists into orbit, the secretive Blue Origin unveils a flying pod. Is your space voyage sooner than you think?

GALACTIC GUMDROP *Goddard* returns to the barn after its November launch.

A MERE THREE YEARS after Burt Rutan's *SpaceShipOne* skimmed the edge of space to capture the $10-million Ansari X Prize, more than half a dozen companies are furiously building and testing spacecraft designed to take paying passengers on suborbital journeys and beyond. Five states—California, Oklahoma, Florida, Virginia and Alaska—now hold government licenses for commercial spaceports, and the Federal Aviation Administration is already working to create new protocols so air-traffic controllers will know how to route old-fashioned airplane flights clear of busy spaceport traffic. "The giggle factor is gone," says Taber MacCallum, CEO of Paragon Space Development Corp. in Tucson, Arizona, one of a number of firms angling to supply future spaceliners with everything from spacesuits to rocket parts.





FLIGHT PLAN A new version of Blue Origin's *Goddard* [top] will compete with Rocketplane Kistler's *Rocketplane XP* [left] and Virgin Galactic's *VSS Enterprise* for passengers.

In January, Amazon.com founder Jeff Bezos grabbed headlines when he revealed that his secretive seven-year-old rocket-science side venture, Blue Origin, had successfully tested a vehicle dubbed *Goddard*. The craft, which launches and lands vertically, is a significant step toward the billionaire's plans for flying sightseers to low Earth orbit and beyond.

A video posted on the company's Web site reveals a gumdrop-shaped capsule whooshing to 285 feet above the West Texas scrub and, cushioned by the thrust of nine rocket nozzles, gently descending onto stubby legs. Bezos wouldn't comment publicly, but a recent 223-page Federal Aviation Administration filing by his rocket

CLOCKWISE FROM TOP: COURTESY BLUE ORIGIN; COURTESY JIM KOEPNICK/VIRGIN GALACTIC; COURTESY ROCKETPLANE KISTLER, INC.

ALTERNATIVE ENERGY

TUNA POWER

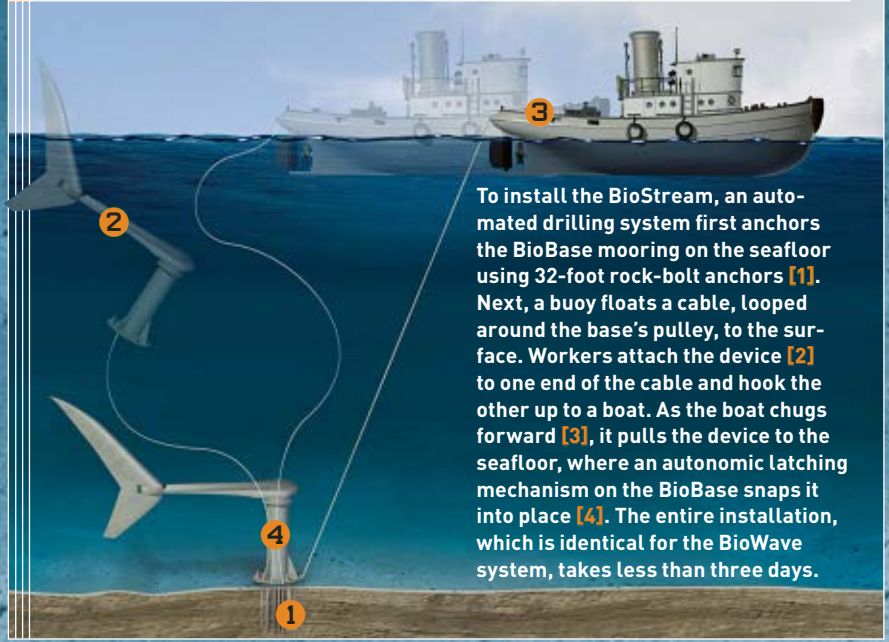
Engineers take lessons from marine life to harness the ocean's energy and light up thousands of homes

WHY SPEND MILLIONS OF DOLLARS designing a device that captures the power of the sea, when nature has already put in a few billion years of R&D work? That was Tim Finnigan's thinking when he adapted shark tails and seaweed into oceanic energy collectors. "I realized the systems that function best in the ocean are the ones that already exist there," says Finnigan, a professor of ocean engineering at the University of Sydney in Australia and the founder of BioPower Systems.

Finnigan's BioStream design is modeled after the most energy-efficient tailfins in the sea, such as those of sharks and tuna, which use a stiff, crescent-shape fin to generate thrust. As the ocean current wags the BioStream's mechanical tail side-to-side, a gearbox converts the oscillation into unidirectional motion to drive a magnetic generator. The kelp-inspired BioWave reaches toward the sea surface to catch passing waves and uses a similar generator to turn the motion of the ocean into electricity. Both models continuously self-align with currents for optimal performance, and their bio-inspired shapes are extremely durable in rough conditions.

BioPower is developing three versions of each design, with the goal of supplying power to customers by next year. At two megawatts, the largest generator would produce enough electricity to power 1,620 homes, Finnigan says. At 8 to 15 cents per kilowatt-hour, the electricity would cost more than other energy sources, but it won't pollute the environment or ruin beachfront views.—BJORN CAREY

INSTALLING A FAKE FIN



To install the BioStream, an automated drilling system first anchors the BioBase mooring on the seafloor using 32-foot rock-bolt anchors [1]. Next, a buoy floats a cable, looped around the base's pulley, to the surface. Workers attach the device [2] to one end of the cable and hook the other up to a boat. As the boat chugs forward [3], it pulls the device to the seafloor, where an autonomic latching mechanism on the BioBase snaps it into place [4]. The entire installation, which is identical for the BioWave system, takes less than three days.

scientists reveals more clues: This year, engineers will attempt to push *Goddard*, which uses concentrated hydrogen peroxide as a propellant, to an altitude of 2,000 feet.

By 2010, Blue Origin hopes to launch weekly suborbital passenger flights in a ship called *New Shepard* (as in Alan Shepard, the first American in space). The 50-foot-tall vehicle will ferry at least three passengers to 62 miles for a few moments of zero gravity at the edge of space, and land using rocket thrusters and a parachute.

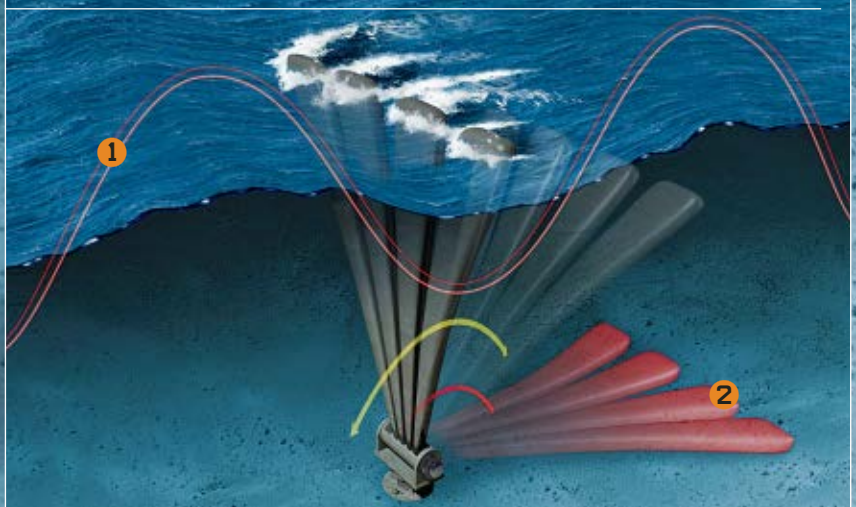
Richard Branson's company Virgin Galactic aims to beat Blue Origin to the launchpad. It plans to test a craft dubbed the *VSS Enterprise* (yes, Spock, that one) next year, with commercial flights as soon as 2009. Designed by Rutan and modeled on *SpaceShipOne*, the 60-foot-long spaceliner will carry six passengers and two pilots.

Now that the FAA is on board with space tourism, "the giggle factor is gone."

Another favored contender in the suborbital space race is Rocketplane Kistler in Oklahoma City. Its craft, the *Rocketplane XP*, is based on a heavily modified Learjet 25 fuselage, with rocket engines delivering 36,000 pounds of thrust. The 44-foot-long vehicle is designed for three passengers and one pilot. Test flights could get under way as early as next year, with commercial flights in 2009, says Bob Seto, the company's vice president.

None of these rides will come cheap. Virgin Galactic is asking $200,000 a ticket, and although Blue Origin has yet to set a fare, you can bet it will cost more than Amazon's two-day shipping upgrade. But even if stratospheric ticket prices don't seem to be deterring eager space tourists—200 people have already booked flights with Virgin Galactic—most companies are well aware that a deadly crash could hurt the flow of wealthy passengers. So with that in mind, the industry is proceeding in the spirit of Blue Origin's lofty Latin corporate motto, *Gradatim ferociter*. Roughly: "Step by step, ferociously."—MICHAEL STROH

MECHANICAL SEAWEED: HOW IT WORKS



The steel-and-fiberglass BioWave works best in waters 45 to 150 feet deep with 2- to 15-foot waves. Its adaptive design allows it to dodge trouble: When waves get too fierce [1], the BioWave automatically shifts to safe mode and lies flat on the seabed [2] so that waves pass over it harmlessly, like a surfer ducking a swell.

KEVIN HAND





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SHRINKAGE
THE QUEST TO MAKE REALLY TINY THINGS

A BETTER BODY CAM

This mini telescope captures budding disease in 3-D

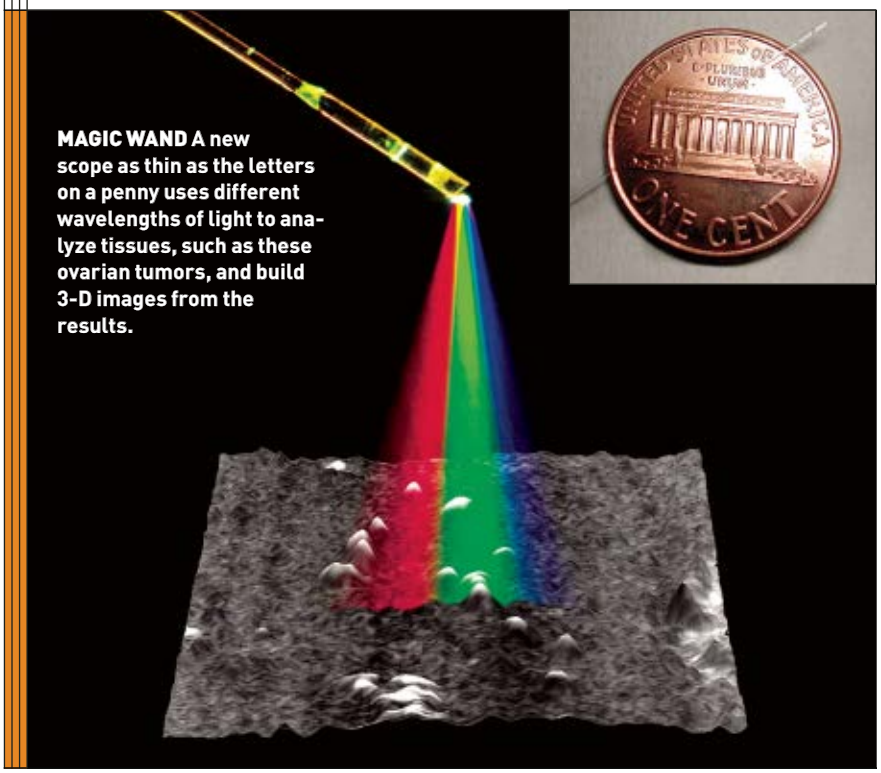
THINK SPORTS look amazing in high definition? Forget about Derek Jeter's hair follicles—wait until you see the inside of your esophagus, courtesy of the world's first high-def miniature 3-D endoscope. It captures images of tumors and other diseases in unprecedented detail and perspective, an innovation that may help physicians spot trouble they would otherwise have missed.

Inventor Guillermo Tearney, a physician at Massachusetts General Hospital in Boston, says, "It's particularly useful in any place where size matters," such as the brain, heart and spine, and in fetuses, where traditional imaging devices are too big to safely go.

Most endoscopes consist of a bundle of fiber-optic cables about a centimeter in width that can damage tissue as they snake into the body. Tearney's scope, in contrast, is a single fiber-optic cable no bigger than the width of a human hair, so in many cases it can be administered without anesthesia.

Increased patient comfort aside, the probe's biggest advantage is its high-quality 3-D views. It illuminates surrounding tissue with a rainbow of colors, using different wavelengths of light to more fully capture uneven surface areas. A spectrometer records the intensity of the light as it reflects off the tissue, and an imaging device renders the data into a crisp 3-D snapshot. The whole procedure can take less than five minutes.

Tearney plans to begin human trials by the end of the year and hopes to make the device available at local hospitals within a few years.—NICOLE DYER



MAGIC WAND A new scope as thin as the letters on a penny uses different wavelengths of light to analyze tissues, such as these ovarian tumors, and build 3-D images from the results.

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WHEELER-DEALER
Steven Schneider and the ethanol-powered Obvio from Brazil

WHAT'S THE BIG IDEA?

WHO KILLED THE GAS GUZZLER?

The leading importer of electric vehicles talks about micro-cars, a 155mph battery-powered SUV and neon paint jobs

STEVEN SCHNEIDER has been selling cars—everything from tiny European imports to boat-like Lincolns—nearly his entire life. Now, as CEO of ZAP (for Zero Air Pollution) in Santa Rosa, California, he specializes in the distribution of small, fuel-efficient automobiles. It's a job, he says, that makes him feel less like "the stereotype car salesman with plaid pants and a white belt." The country's largest retailer of electric vehicles—90,000 sold worldwide since 1994, including 300 electric cars but mostly ATVs and golf-cart-size vehicles—ZAP recently introduced the fastest production electric car in the country, a three-wheeler called the Xebra that can hit 40 miles per hour. By the end of next year, ZAP will introduce the Obvio, a pint-size Brazilian import that will be the nation's first commercial car to run on 100 percent ethanol, followed by a Lotus Engineering electric SUV that will top 155mph. We spoke with Schneider about his thriving eco-dealership and his ambitious vision of a green automobile for every driver in America.—GREGORY MONE

Q: Why aren't electric cars more popular in the U.S.?
A: Those of influence don't promote them. I hate to be so vague, but we're not looking to make any enemies. That said, I believe that within the next few years, due to public demand, we'll start to see more of them.

Q: The Xebra is efficient, but what's the point if the range is only 40 miles?
A: It's a great little inner-city commuter or country-road vehicle. It's technically freeway-legal, but it's not built for that. With it, we've introduced electric-drive technology at an affordable price—under $10,000.

Q: What's with the zebra stripes and neon paint job?
A: People want to be noticed. They want to stand out in a crowd. It's the same for Ferrari or Rolls-Royce drivers.

Q: Who's buying your cars?
A: Families, people who want to make a difference, people who want to save money, people who want to make money, and everyone in between. But electric cars also bring a lot of benefits for fleet applications and city government and utilities. Our little Xebra truck is the ideal meter-maid vehicle.

Q: What about those of us who want more than a short-range cruiser?
A: We've partnered with Lotus Engineering to introduce an entire

TIMOTHY ARCHIBALD



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line of green but very advanced vehicles. One is an electric SUV called the ZAP-X that we expect to sell in the $60,000 range next year [see "Burning Rubber, Saving Fossil Fuel," right]. Its all-aluminum frame allows us to add additional batteries that give it a 350-mile range, a penny-a-mile operational cost, 155mph capability, touchscreen controls, and all-biometric entry and ignition.

Q: Where will we charge up?
A: In the early stages, people will just plug in at work, restaurants, their homes. Costco and Wal-Mart already have outlets available. The infrastructure will change so you'll just put a few quarters in a station and start refueling. The Xebra takes four hours to recharge, but the ZAP-X comes standard with a new fast-charging lithium battery. Plug it in, and 10 minutes later you're on your way.

Q: Will it kill your electric bill?
A: No, because it costs about a dollar to refuel the Xebra, and roughly $3.50 for the ZAP-X.

Q: So from the Xebra to the ZAP-X, is your basic idea to have an alternative-fuel car for all consumers, except maybe the Hummer-lovers?
A: Even the Hummer driver.

THE ZAP-X WON'T KILL YOUR ELECTRIC BILL—IT COSTS ABOUT $3.50 TO REFUEL.

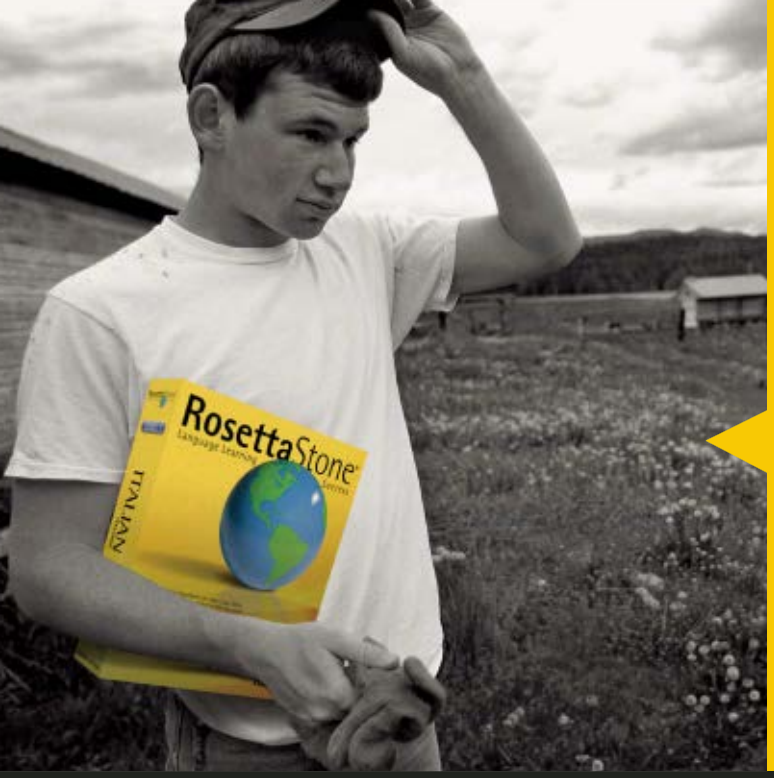
BURNING RUBBER, SAVING FOSSIL FUEL

FOR DRIVERS prepared to forgo gasoline but not legroom or power, ZAP is partnering with Lotus Engineering to deliver the first all-electric road-ready SUV. Called ZAP-X and slated to hit the ZAP showroom next year, the vehicle will feature a number of surprising performance perks. For starters, in-hub electric motors, which manage the torque at each wheel, will replace a central engine to deliver a staggering 644 horsepower and enable a top speed of 155 mph. That's more than 25 miles an hour faster than the new, Lotus-built electric Tesla Roadster. The SUV will also feature the longest range of any electric vehicle—350 miles on a single charge—thanks to computer-controlled lithium batteries. Of course, having your cake and eating it too won't be cheap: The anticipated sticker price is roughly $60,000.—DAKIN CAMPBELL



GOOD TO BE GREEN By next year, ZAP plans to debut a 155mph luxury electric SUV made by Lotus Engineering.

POPSCI NEXT ISSUE Don't miss the May special issue on the future of the car!



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THE EQUATION

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UV RAYS



CELLPHONE



MR. PREPARED

CELLPHONES DON'T OFFER much shade on a bright day. But in December, Philips Electronics filed a patent on a system that would allow the devices to help prevent sunburns and skin cancer. The plan integrates information about a cellular customer's location with real-time local data about how much ultraviolet radiation—the component of sunlight that can harm skin—is hitting the area, as measured by the National Weather Service or yet-to-be-installed sensors at popular outdoor spots like beaches and ballparks. The service would tell you, through a text message or audio alert, when to sunbathe, when to seek shade and how long your sunscreen will stay effective, all based on information about your location and skin tone and the type of lotion being used. "With the health importance of avoiding sunburns, this struck me as a positive application," says George Marmaropoulos, the Philips designer who invented the scheme. The company needs to find partners, but the service could be ready within three years.—JEBEDIAH REED



FRIED FISH Warmer oceans could mean fewer fish in the sea—and pricier seafood.

30-SECOND SCIENCE

OCEAN LIFE IN HOT WATER

Global warming is taking a toll on fish—and helping jellyfish rule the sea

1 PALTRY PLANKTON Using a decade's worth of satellite data, scientists have determined that rising ocean temperatures are killing phytoplankton. Not only do these tiny plants form the base of oceanic food webs, they also process as much carbon dioxide and produce as much oxygen as land plants do. Although the findings may be influenced by El Niño, the researchers say the the study provides a sneak peek at how ocean biology will evolve as the climate continues to change.

2 GASPING FOR AIR German scientists have found that eelpouts (elongated fish with eel-like heads) require more oxygen to perform basic functions as water temperatures increase—a big problem because warmer waters contain less oxygen. Despite eelpouts' better-than-average tolerance of thermal fluctuations, their population decrease in the North Sea has coincided with rising temperatures. Less-hardy fish such as Atlantic cod are suffering similar effects.

3 HEAT MISERS Jellyfish will actually thrive in warmer oceans—bad news for dozens of fish species, says biologist Martin Attrill of the University of Plymouth in England. Attrill has analyzed 50 years' worth of data from the North Sea and found that jellyfish are more prevalent in warm-water years. As seas continue to heat up, this could pose trouble for cod, salmon and other commercial fish: Jellyfish not only outcompete fish larvae for food but eat them too.—BJORN CAREY

CLOCKWISE FROM TOP LEFT: STOCKDISC/GETTY IMAGES; PRISMA/SUPERSTOCK; COMSTOCK/SUPERSTOCK; RAIMUNDO VALENTIM/EPA/CORBIS



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Vehicle shown with available equipment. ©2006 Toyota Motor Sales, U.S.A., Inc.

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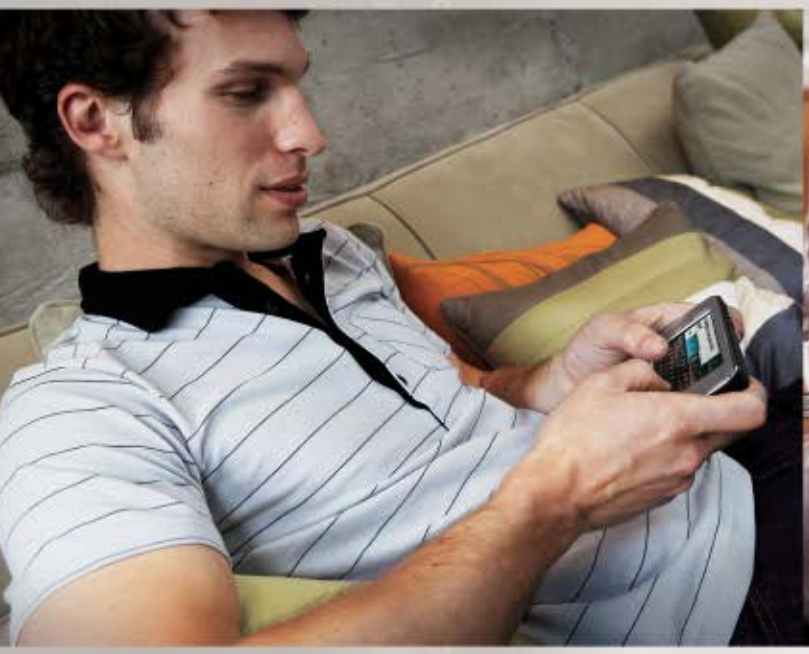
Entertainment



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Calling all passionate Nokia N800 Internet Tablet users—here's your chance to shine!

Nokia and Popular Science want to hear about the innovative ideas that you have for the Nokia N800 Internet Tablet. Tell us how would you personalize the Nokia N800 and make it even cooler.

How It Works: The idea is to come up with the most compelling application, service, script, hardware addition or anything that you will use on the Nokia N800.

Your entry must be creative, useful, appealing, fun, versatile or extremely innovative—something that truly impacts people's lives. For example, your ideas could be about streaming media, remote control capabilities, creating graphs or any other unique or compelling idea.

To get your creative juices flowing, visit www.maemo.org for additional ideas.

How To Enter: Submit your entry to **www.popsci.com/nokia**. Full details on how to submit, selection criteria, and chances to win are listed on this Web page.



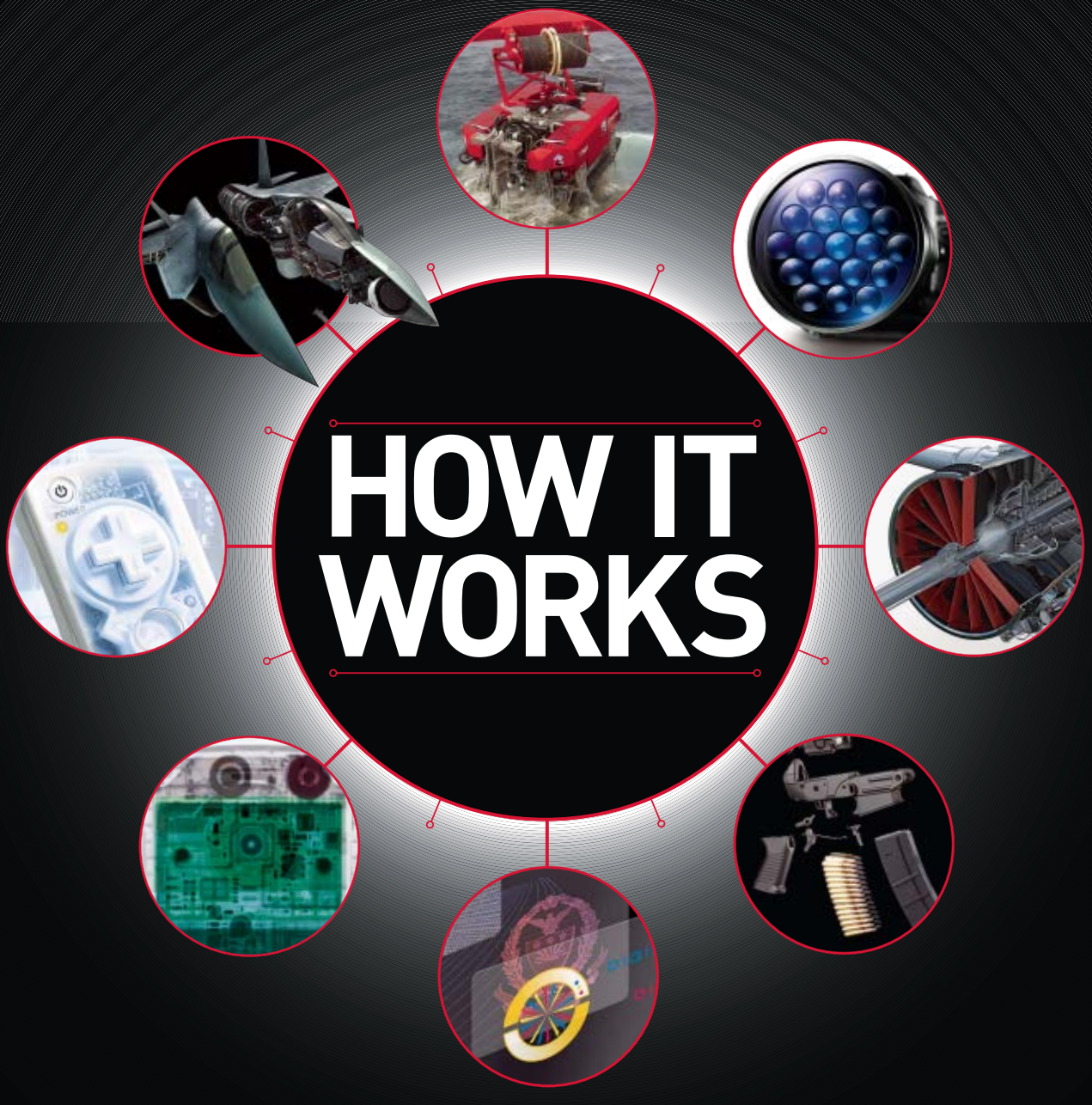
How We Pick The Winners: The entries will be judged by Nokia staff and the editors of Popular Science. They will select two of the best Nokia N800 innovations.

The first winner will be featured in the May issue of Popular Science magazine and the second winner will be featured in the June issue. Each winner will show off his or her winning idea in the magazine.

And that's not all. If the idea is truly knock-your-socks-off brilliant, Nokia will consider integrating it into a future generation of the Internet Tablet, as well as naming the idea after the winner.

Deadline: There are two chances to enter. For consideration in the May issue, submit your entry by February 27, 2007. For the June issue, submit your entry by March 29, 2007.

NO PURCHASE NECESSARY TO ENTER OR WIN. The "Nokia and Popular Science ReaderContest" is open to legal residents of the 50 United States and the District of Columbia age 18 or older at time of entry. To enter and view complete Official Rules, which govern this Contest, visit www.popsci.com/nokia. Contest begins at 12:01 AM Eastern Time (ET) on 2/13/07 and ends at 11:59 PM (ET) on 3/29/07. There are two chances to enter. For consideration in May issue, submit your entry by 2/27/2007. For June issue, submit your entry by 3/29/2007. Void where prohibited. Sponsor: Popular Science. Nokia, Nseries and N800 are trademarks or registered trademarks of Nokia Corporation.



HOW IT WORKS

A **jet fighter** sliced in half.
An **automatic rifle** ripped apart.
The **newest phone**—x-rayed.
We tore open **everyday devices** and complex machines you've **never seen** to show you the **extraordinary tech** that makes them work.

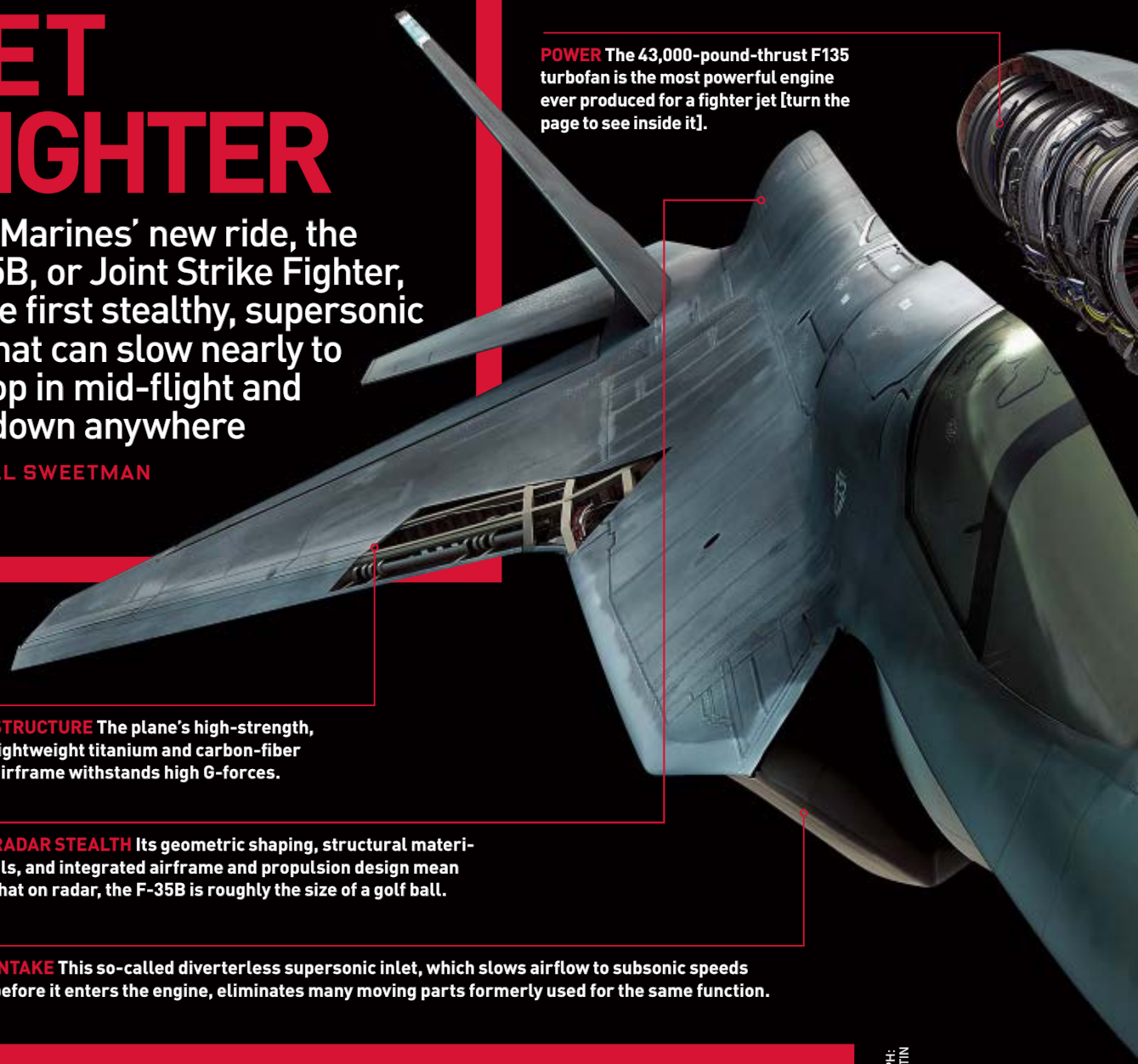
THE MOST ADVANCED JET FIGHTER

The Marines' new ride, the F-35B, or Joint Strike Fighter, is the first stealthy, supersonic jet that can slow nearly to a stop in mid-flight and set down anywhere

BY BILL SWEETMAN

1. WHY BUILD IT?

The 400 short-takeoff/vertical-landing (STOVL) F-35Bs ordered by the Pentagon will replace both the F/A-18 Hornet and the British-built Harrier STOVL fighter, which is slow, hard to fly and not stealthy. The F-35B lets Marines launch missions from small ships instead of Navy carriers.



POWER The 43,000-pound-thrust F135 turbofan is the most powerful engine ever produced for a fighter jet [turn the page to see inside it].

STRUCTURE The plane's high-strength, lightweight titanium and carbon-fiber airframe withstands high G-forces.

RADAR STEALTH Its geometric shaping, structural materials, and integrated airframe and propulsion design mean that on radar, the F-35B is roughly the size of a golf ball.

INTAKE This so-called diverterless supersonic inlet, which slows airflow to subsonic speeds before it enters the engine, eliminates many moving parts formerly used for the same function.

ILLUSTRATION: NICK KALOTERAKIS; PHOTOGRAPH: COURTESY LOCKHEED MARTIN

3. HOW DOES IT TAKE OFF?

Although the F-35B can land vertically, it needs a running start—as little as 300 feet—to take off. It begins its takeoff roll with the main engine pointing back. At a paltry 80 knots, the engine nozzle and lift-fan exhausts all swing halfway down to give the plane vertical lift and send it airborne.



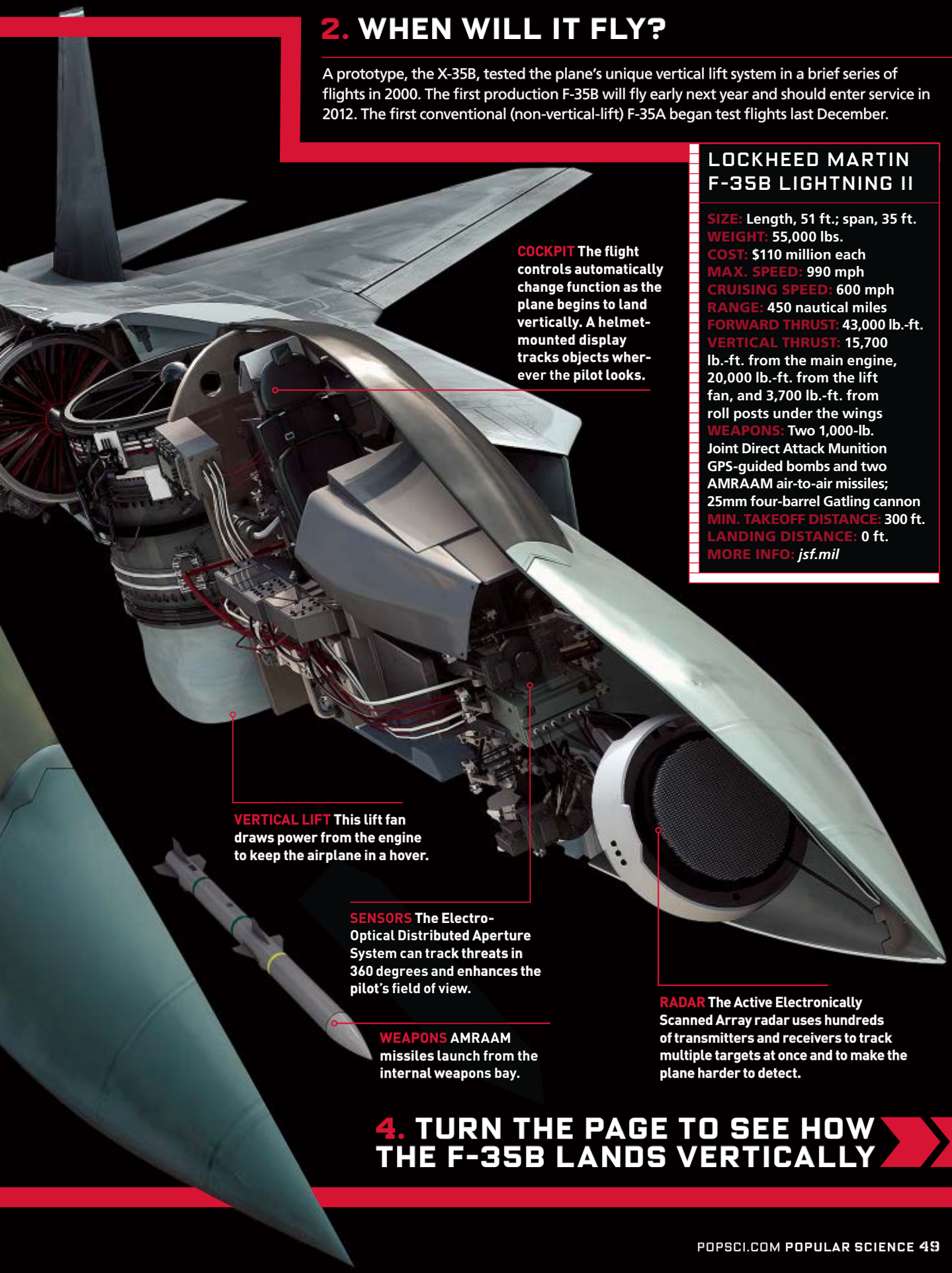
IN MOTION The standard F-35 during a January test flight

2. WHEN WILL IT FLY?

A prototype, the X-35B, tested the plane's unique vertical lift system in a brief series of flights in 2000. The first production F-35B will fly early next year and should enter service in 2012. The first conventional (non-vertical-lift) F-35A began test flights last December.

LOCKHEED MARTIN F-35B LIGHTNING II

SIZE: Length, 51 ft.; span, 35 ft.
WEIGHT: 55,000 lbs.
COST: $110 million each
MAX. SPEED: 990 mph
CRUISING SPEED: 600 mph
RANGE: 450 nautical miles
FORWARD THRUST: 43,000 lb.-ft.
VERTICAL THRUST: 15,700 lb.-ft. from the main engine, 20,000 lb.-ft. from the lift fan, and 3,700 lb.-ft. from roll posts under the wings
WEAPONS: Two 1,000-lb. Joint Direct Attack Munition GPS-guided bombs and two AMRAAM air-to-air missiles; 25mm four-barrel Gatling cannon
MIN. TAKEOFF DISTANCE: 300 ft.
LANDING DISTANCE: 0 ft.
MORE INFO: *jsf.mil*



COCKPIT The flight controls automatically change function as the plane begins to land vertically. A helmet-mounted display tracks objects wherever the pilot looks.

VERTICAL LIFT This lift fan draws power from the engine to keep the airplane in a hover.

SENSORS The Electro-Optical Distributed Aperture System can track threats in 360 degrees and enhances the pilot's field of view.

WEAPONS AMRAAM missiles launch from the internal weapons bay.

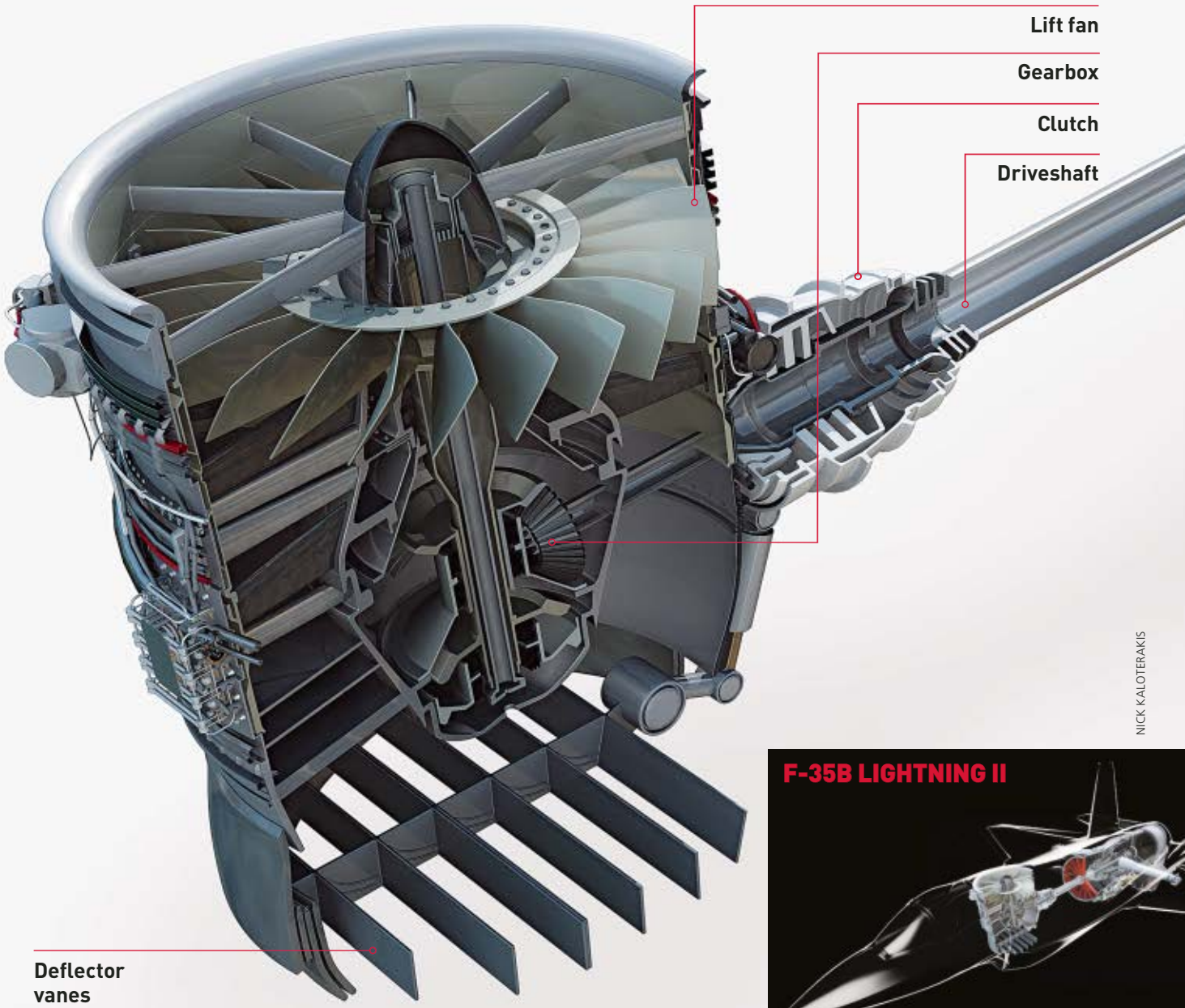
RADAR The Active Electronically Scanned Array radar uses hundreds of transmitters and receivers to track multiple targets at once and to make the plane harder to detect.

4. TURN THE PAGE TO SEE HOW THE F-35B LANDS VERTICALLY

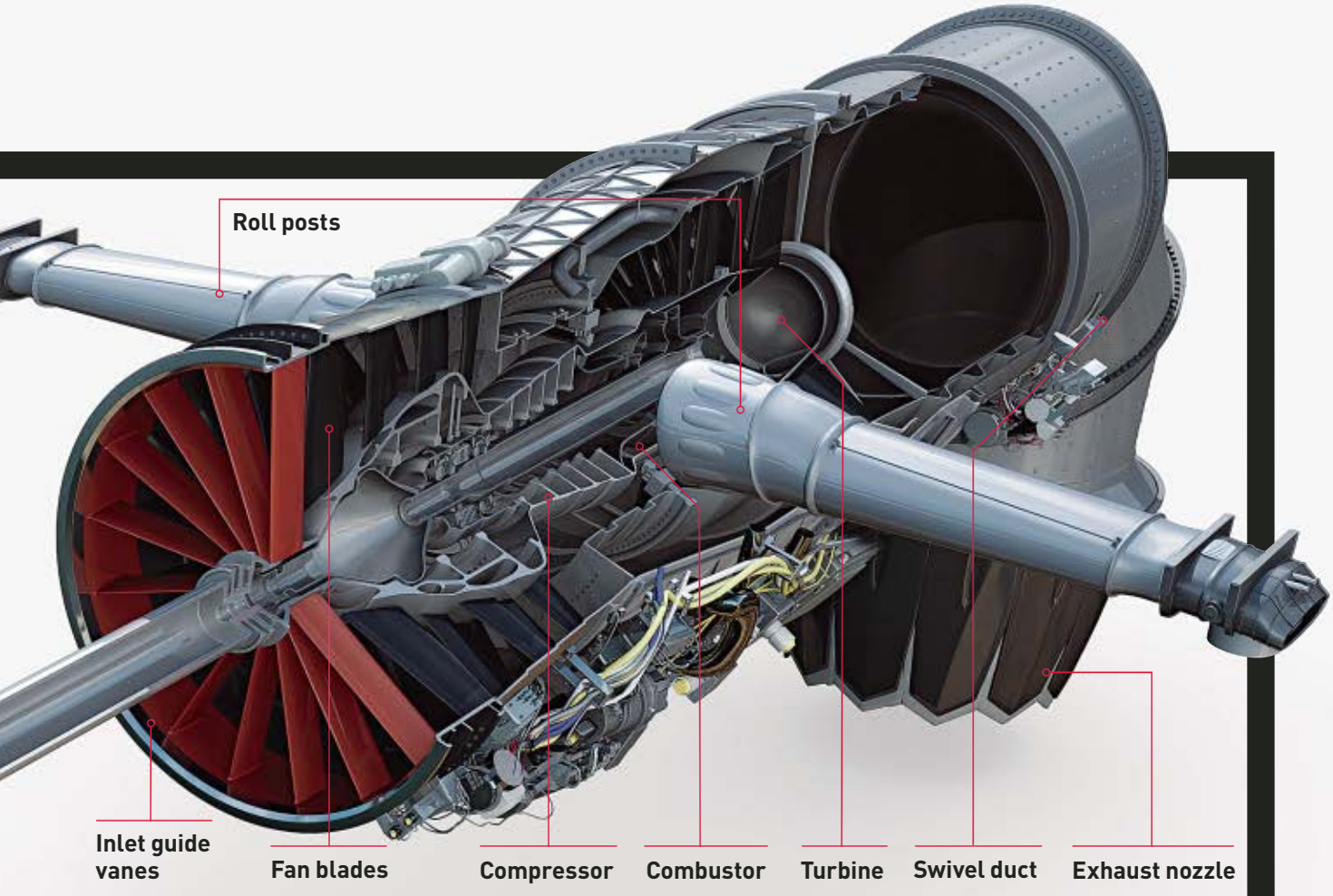
THE F-35B'S AMAZING ENGINE

This two-part beast can drive a jet at supersonic speeds, then hold it in midair

DESIGNING A SUPERSONIC short-takeoff/vertical-landing (STOVL) jet has stumped aviation engineers for decades. First you have to give the airplane enough thrust to overcome its weight, since wings generate no lift at a dead stop. Then you have to bend the thrust so that it points straight down—and, by the way, the engine has to steer and stabilize the airplane, because the regular flaps and controls also stop working when it's not moving. And all this has to happen in midair. Here's how the F-35B—engine by Pratt & Whitney and lift system by Rolls-Royce—does it.—BILL SWEETMAN



NICK KALOTERAKIS



HOW THE JET DROPS FROM THE SKY

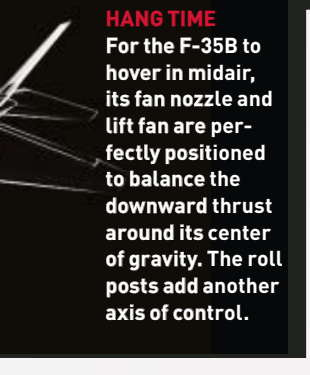
1. While the plane is still flying horizontally, doors on the top and bottom of the body open to expose a **lift fan** that sits vertically just a few feet behind the cockpit and is driven by the engine via a **driveshaft** and gears.

2. The engine throttles back briefly to engage the **clutch** and **gearbox** and start the lift fan. Once the clutch is locked, the engine goes back to full power, transmitting 29,000 horsepower (think: seven locomotives) to the lift fan to start generating vertical thrust.

3. The main engine's **swivel duct** gradually deflects the **exhaust nozzle** downward.

4. Another set of valves deflects part of the thrust into **roll posts** under the jet's wings—these help balance the jet and keep it from rolling. The plane continues to slow down until the jet nozzle in back and the **deflector vanes** in the lift fan are pointed straight down. As the F-35B slows to a hover, the pilot is still flying with the normal cockpit controls—a stick, rudder pedals and a throttle—but they now control the rate of descent and forward speed, as well as rotating the airplane around its vertical axis.

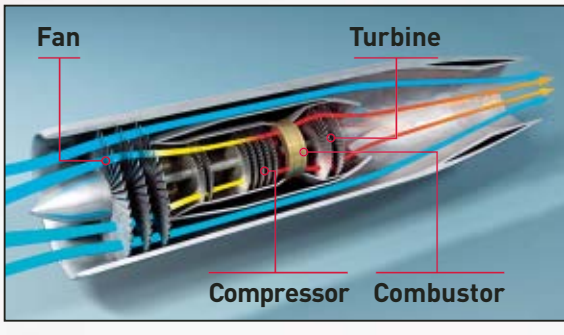
5. The fighter hovers, supported only by jet power. Computers constantly adjust the main and fan nozzles, the left and right roll posts and the throttle to keep the F-35B straight and level.



HANG TIME
For the F-35B to hover in midair, its fan nozzle and lift fan are perfectly positioned to balance the downward thrust around its center of gravity. The roll posts add another axis of control.

JET ENGINES 101

Jet engines use a simple sequence to create thrust: suck, squeeze, burn, blow. Several fans at the front of the engine suck air in. "Primary" air enters the heart of the engine, while "bypass" air accelerates around the core. Smaller fans then squeeze the primary air, increasing its temperature and pressure. A combustor adds and burns fuel to make the compressed air even hotter. That superheated stream of air shoots through a turbine, spinning it to keep the compressor and fan at the front moving. When the primary and bypass air merge behind the turbine, the air accelerates as it's blown through the narrow exhaust nozzle, producing thrust.





THE PHONE THAT TOUCHES YOU BACK

Hitting virtual keys on the screens of next-generation cellphones will feel just like pressing real buttons. The secret: a motor like the one that vibrates your phone today—and a little mind trick BY SARAH Z. WEXLER

THE DETAILS

HOW IT VIBRATES

ALL CELLPHONES shake when a small weight somewhere inside them moves vigorously. Most vibrate at only one speed, but newer phones, such as the Samsung model shown here, use a more precise system in which the rate and intensity of the vibration can be quickly changed.



THE OLD WAY
An electric current spins a motor with an off-center weight on the shaft up to 10,000 rpm, shaking the whole phone.



THE NEW WAY
An electromagnetic field from a copper ring bounces a magnet suspended from a spring.

FAKING THE FEEL OF BUTTONS

1. TOUCH THE SCREEN

An ultrathin layer of electrically conductive material coats the touchscreen, so when you press down on the image of a button onscreen, your finger causes a change in the electrical current, a process known as resistive technology. This prompts software to send motor-control instructions to a chip inside the phone.

2. SET IT ABUZZ

On typical phones, the vibration is either on or off, but this chip allows the motor to receive positive or negative current (producing forward or backward spin) at specific voltages and intervals. This means it can ramp up or down precisely enough to produce a quick staccato movement that feels like the click of a physical button, what's called "haptic feedback." (It can also vibrate along to a thumping bass line in a song or the soft patter of raindrops in a game.)

3. FOOL THE BRAIN

And now the dirty secret: When you push the "3" button, although it feels like only the screen under the "3" moves, in fact the entire phone vibrates—the same as it would if you pushed the "9" or the "1." It's an illusion that plays on the context-specific way your brain processes information. You're expecting a response from the spot you pushed, so your brain classifies the resulting vibration as direct, localized feedback. You feel (and hear) the exact same *click* of pressing down on an actual button—a ruse that took 12 years to get just right.

THIS PAGE: ILLUSTRATIONS: KRIS HOLLAND; PHOTOGRAPH: SATOSHI; FACING PAGE: X-RAY: NYU/EMILIO VEGA USING SIEMENS DIGITAL RADIOGRAPHY

SAMSUNG SCH-W559

SIZE: 3.5 in. x 1.9 in. x 0.5 in.
WEIGHT: 3.2 oz.
NETWORK: GSM 900/1800MHz; CDMA 800MHz
AVAILABLE: Now, China only
MORE INFO: *samsung.com*

THE SAMSUNG SCH-W559 phone is the first with a haptic-feedback touchscreen. In addition to the vibrating actuator, it contains software from a company called Immersion that orchestrates the actuator's movements down to the millisecond. A two-millimeter control chip costs manufacturers 10 cents, so it and the software could become standard in phones in the next three to five years.



OTHER USES FOR HAPTIC FEEDBACK

GAMING

Controllers for Playstations, Xboxes and arcade games use two motors (one large and one small) to produce a wide range of sensations, such as the feel of gravel when you drive off the road.

MEDICAL TRAINING

Immersion also makes a kind of advanced version of the game Operation that gives practicing surgeons feedback identical to actual surgery, down to the jelly-like feel of the gastrointestinal wall. The system relies on what's called force feedback, which uses haptic motors, plus magnets and springs, to give the sensation of resistance instead of vibration.

TIP: HOW TO GO HAPTIC

Although the SCH-W559 won't hit the U.S. until late this year, China uses the same network (GSM) as Cingular and T-Mobile, so you can try buying one from an importer such as *dynamism.com* or *mobileplanet.com* and slip in your SIM card. You can also get one of many haptic-enabled Samsung Vibetonz phones through Sprint or Verizon, but these use the vibration only for ringtones and alerts—for now, you still have to place calls by punching actual buttons.

THE CABLE MONSTER

Know why you can make a call to England or pump cheap gas? Because this remote-control tank digs six-foot-deep trenches in the ocean floor to lay and bury thousands of miles of cable and pipeline

BY LAUREN AARONSON



OVERBOARD The trencher goes to work.

THE DETAILS

HOW TO PLANT CABLES IN THE SEA

1. MAP THE ROUTE

Before the Triton T750 lays cable, engineers complete a "route and hazard survey"—in which a robot takes pictures of the seabed and checks for underground rocks with field-sensing magnetometers—to plan an efficient, obstacle-free path.

2. DROP THE MACHINE TO THE SEAFLOOR

The crew lowers the T750 from a ship and maneuvers the unmanned vehicle using a computer connected by a 2,000-yard cord. As the cable to be laid unspools from the ship's deck, the machine follows it along the seabed. On stiff soil, hydraulically powered treads carry the trencher. But on soft, unstable soil, it skids across the ground on skis. Eight 50-kilowatt fan-like thrusters propel it forward.

3. DIG THE TRENCH

Making the most of its environment, the T750 does its digging with water. Pumps force seawater through 48 nozzles on each of two steel arms, blowing away the seabed to make a trench one to three yards deep directly under the pipe or cable. A sandy bottom requires a low-pressure, high-volume flow; a high-pressure stream cuts through tough clay. Operators control the flow, as well as how deep the six-foot arms plunge, from the surface.

4. CLEAR THE SLUSH

A vacuum pump sucks slurry from the trench and spits it out an exhaust pipe on the side. As the trench empties, the pipe or cable—filled with heavy fluids so it doesn't float away—sinks into the hole.

5. COVER ITS TRACKS

The pipe or cable in place, the ship reels the machine back to the surface, where it's outfitted with a backfill tool for burying. On each side of the trench, one water jet blows into the bottom of the trench wall, while another jet pushes down on the top, and the trench caves in on itself.

TRITON T750

SIZE: 25 ft. 6 in. x 16 ft. 10 in. x 10 ft. 3 in.
WEIGHT: 25 tons
HORSEPOWER: 750
MAX. DEPTH: 4,900 ft.
BURYING SPEED: Up to 1.2 mph

SONAR BEACON conveys the trencher's location

DREDGE PUMP clears away slurry

CABLE unspools from a ship on the surface

READY TO ROCK The Triton T750, built by Perry Slingsby Systems in England and operated by Canyon Offshore in the Gulf of Mexico and elsewhere, is one of the most sophisticated trenchers ever made, able to adjust to different kinds of soil. This spring, a new steel cutting wheel will let it run oil and gas pipelines through previously unpassable solid rock.

ILLUSTRATIONS: GRAHAM MURDOCH; PHOTOGRAPH: COURTESY CANYON OFFSHORE



TRANSPONDER beams location to the ship

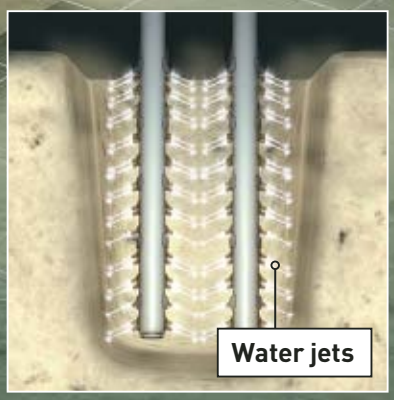
SKIDS skim across the soft seafloor

THRUSTERS maneuver the machine

UMBILICAL cable connects to computers and electrical power on the ship

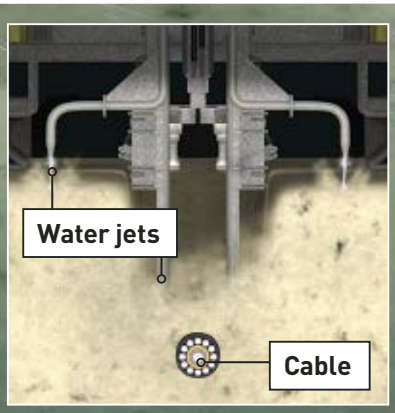
WATER JETS break up soil to create the trench

DIGGING THE TRENCH



A total of 96 nozzles cut into the seafloor by shooting water from jets at 200 psi—three times the pressure of your shower head.

COLLAPSING THE TRENCH



To bury the cable, water jets weaken the top and bottom of the trench, creating a mini avalanche.

THE SHARPEST-SHOOTING CAMERA



Say goodbye to blurry shots. Tomorrow's digital cameras will shoot the same scene from dozens of perspectives at once, creating a three-dimensional image that lets you choose the focus later

BY JONATHON KEATS

MEGAPIXELS ARE GETTING CHEAP. A 22-megapixel cellphone camera is feasible today, and within a few years 300-megapixel sensors could be common. But lenses, ground from glass, can't focus light sharply enough to take advantage of this windfall. In other words, at some point you simply can't capture any more detail. Engineers at Adobe Systems, pioneers of Photoshop, see this limitation as an opportunity to rethink photography and put those megapixels to work. Their prototype "light field" lens attaches to a normal digital camera to shoot the same image from dozens of focal points at once. Later, software combines all the images, so you can refocus your photos *after* they've been shot. A system from Stanford University researchers achieves a similar effect by placing a lens like this directly over the camera's sensor.

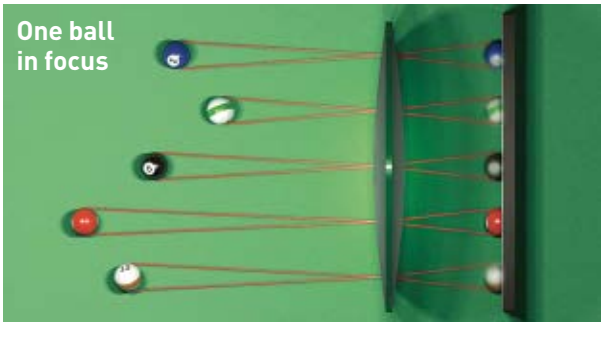
ADOBE PROTOTYPE LIGHT-FIELD LENS

SIZE: 5 in.
NUMBER OF SHOTS IT CAPTURES AT ONCE: 19
AVAILABLE: Adobe built this prototype to demonstrate its software, but commercial versions could arrive in five years.

THIS PAGE: ILLUSTRATIONS: KRIS HOLLAND; PHOTOGRAPH: GARRY McLEOD; FACING PAGE, FROM TOP: GARRY McLEOD; JAVIER PIERINI/GETTY IMAGES (5)

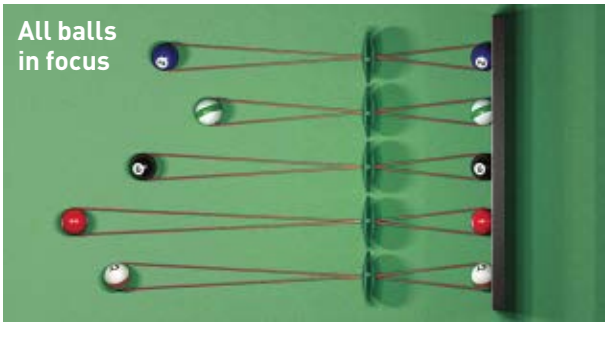
THE DETAILS

HOW A STANDARD CAMERA WORKS



STANDARD CAMERAS gather light through a single central lens and project it onto a sensor, making a flat picture with only one focal point per image. Humans, on the other hand, view objects from two perspectives at once (called binocular vision), so we're sensitive not only to the location of light rays but also to their angle. This lets us see the full depth of what's in front of us and choose where to focus.

HOW THE LIGHT-FIELD CAMERA WORKS



1. TAKE SEVERAL SHOTS AT ONCE
With multiple eyes—Adobe's prototype has 19—the light-field camera is even more perceptive. Each of its lenses is faced with a prism set at a unique angle, so it can take 19 pictures simultaneously, with each capturing a different part of the scene in focus. Each image uses a piece of the sensor, so a 100-megapixel camera will yield 19 5.2-megapixel shots.



MANY EYES This working prototype lens from Adobe can take 19 photos at once, each with a different focal point.



2. FILL IN THE BLANKS
Adobe software can analyze the 19 captured photos and, from them, generate thousands of intermediate images so that each shot seamlessly morphs into those adjacent. Then images are layered, like thin sections, producing a three-dimensional simulation of the scene in which every piece of it is in focus.



3. PAINT IN YOUR FOCUS
Because a light-field photograph is dynamic—virtually three-dimensional—focus can be selectively painted in with a "focus brush," allowing the photographer to bring details from both foreground and background into focus—something that's currently impossible in a single photo. Future online photo sites could let viewers manipulate a photo's focus as they chose.



FLUORESCENT INKS Images that glow under ultraviolet light enable, say, bartenders to check for a hidden birth date or let police look for a secondary photo to verify authenticity.

LASER ETCHING A highly focused laser inscribes the signature, creating a unique raised tactile pattern that cannot be reproduced by embossing or any other means.

DIGITAL WATERMARKING Feds or bouncers can screen out phonies by verifying that license photos are genuine. The best tool for doing this is covert digital watermarking. License-makers create several slight alterations to the photo while it's still in digital form. That adds a layer of data to the portrait that, when printed, will be imperceptible to the human eye but will reveal statistics about the image readable by a scanner (which can be as simple as a PDA with a camera running special software). For example, the photo's colors could be altered slightly so that a specific value of color showed up a specific number of times. If the scanner doesn't see the correct pattern in the watermark, it flags the ID as suspect.

EXAGGERATED WATERMARK

THE MOST SECURE ID

Want to see the best counterfeit-resistant technology in existence? Check your wallet. Congress will begin enforcing uniform security standards for state driver's licenses in 2008, incorporating some or all of the measures here to foil fake-ID-wielding terrorists and teenagers alike BY ELIZABETH SVOBODA

ILLUSTRATION: KEVIN HAND; FACING PAGE: SATOSHI



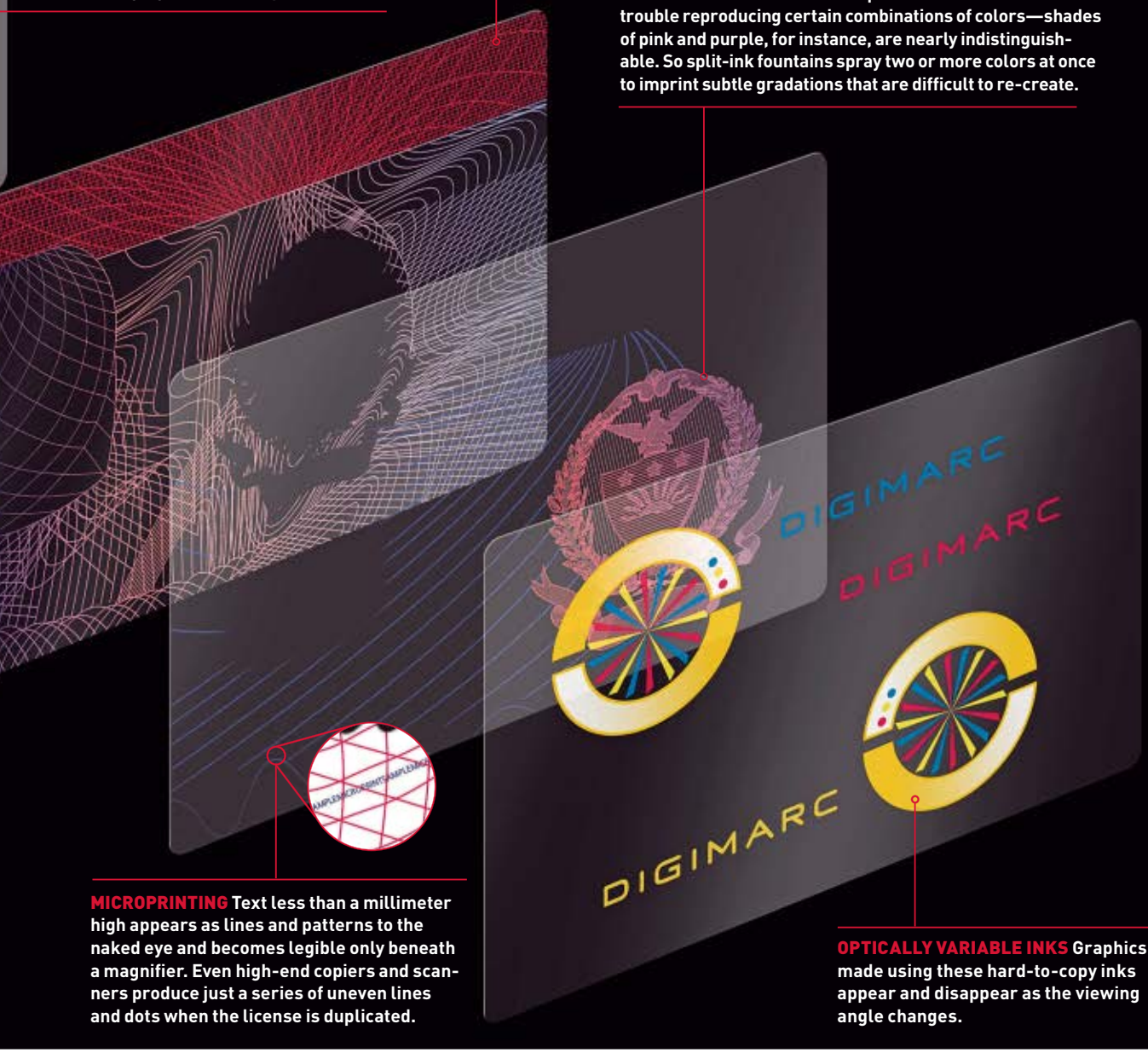
IT'S IN THE CARD This sample license is made by Beaverton, Oregon-based Digimarc, which produces licenses for 32 states and 20 countries.

LASER PERFORATION Barely perceptible at first glance, these holes, punched with an ultrafine laser too expensive to be accessible to most counterfeiters, spell out code words when held up to a bright light.

GUILLOCHE PATTERNS Plotted and printed by hard-to-get equipment, these fine geometric tracings cannot be copied unless a counterfeiter knows the mathematical formulas that describe the slope and direction of the curves.

GHOST IMAGES Having multiple copies of your photo makes tampering tough: Any attempt at photo-swapping also requires changing the overlaid printed data.

SPLIT-FOUNTAIN PRINTING Copiers and scanners have trouble reproducing certain combinations of colors—shades of pink and purple, for instance, are nearly indistinguishable. So split-ink fountains spray two or more colors at once to imprint subtle gradations that are difficult to re-create.



MICROPRINTING Text less than a millimeter high appears as lines and patterns to the naked eye and becomes legible only beneath a magnifier. Even high-end copiers and scanners produce just a series of uneven lines and dots when the license is duplicated.

OPTICALLY VARIABLE INKS Graphics made using these hard-to-copy inks appear and disappear as the viewing angle changes.

Advertisement

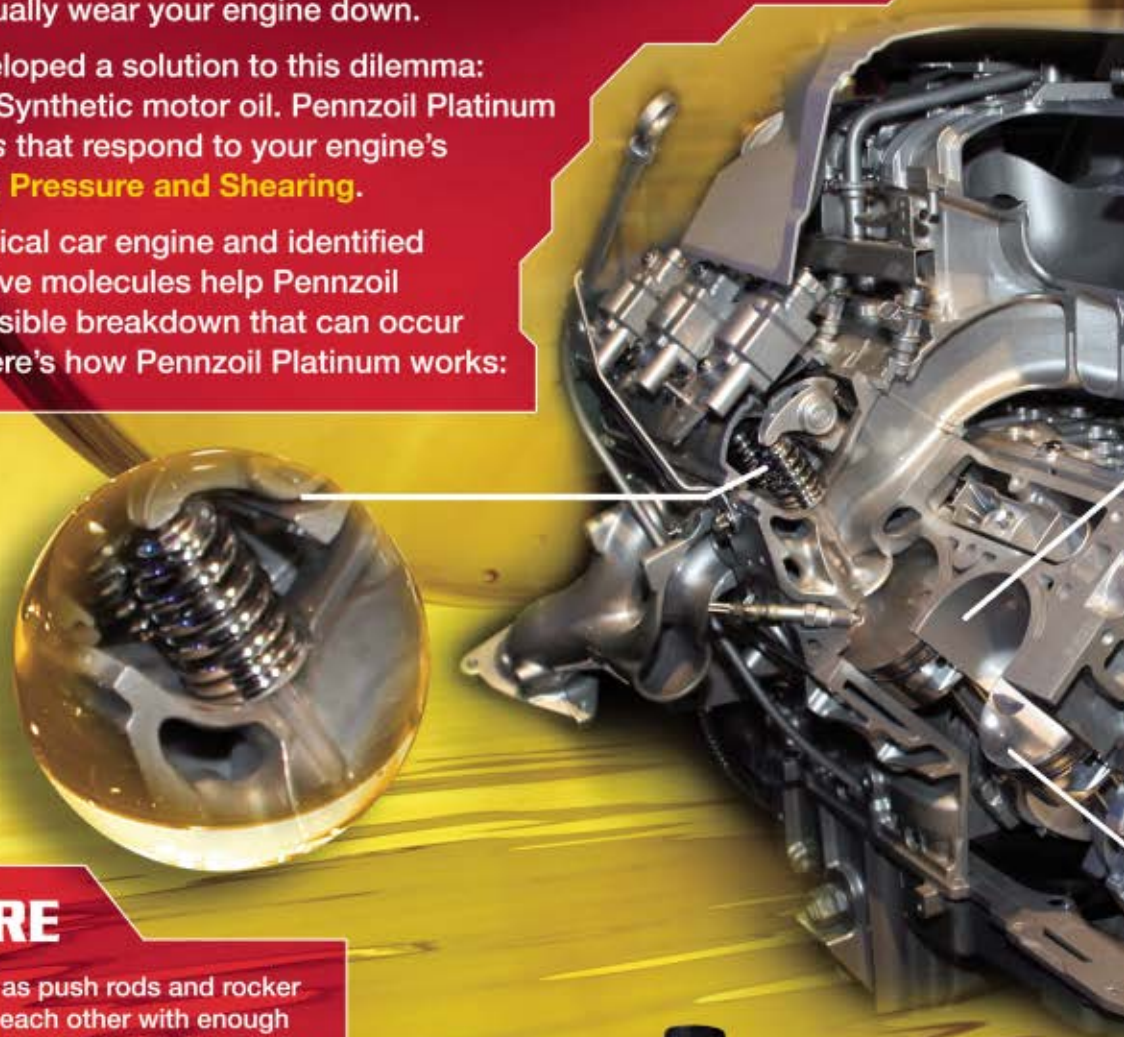
HOW PENNZOIL PLATINUM® FULL SYNTHETIC MOTOR OIL WORKS

Protect Your Engine From Heat, Pressure, and Shearing

When an engine is running, its insides can be a violent place. Pounding explosions, extreme temperature and the grinding of steel parts are necessary to create motion. Ironically, the very process that gives your engine power is the same process that will eventually wear your engine down.

But Pennzoil® has developed a solution to this dilemma: Pennzoil Platinum Full Synthetic motor oil. Pennzoil Platinum has *adaptive molecules* that respond to your engine's biggest enemies: **Heat, Pressure and Shearing**.

We took a look at a typical car engine and identified the spots where adaptive molecules help Pennzoil Platinum resist the possible breakdown that can occur in regular motor oil. Here's how Pennzoil Platinum works:



PRESSURE

Engine parts, such as push rods and rocker arms push against each other with enough pressure to crush motor oil that gets caught between them. When Pennzoil Platinum® is faced with pressure its adaptive molecules cluster together, creating a cushion or barrier to absorb the impact – like microscopic shock absorbers.



Not just oil, Pennzoil®

Advertisement



HEAT

Cylinder walls get hot enough to break down motor oil. But when Pennzoil Platinum® senses severe heat, the adaptive molecules split to avoid shearing, yet stay strong enough to provide excellent protection. When the heat is gone, the molecules reform.

SHEARING

Tight spots, such as the piston rings, can tear motor oil apart, causing permanent viscosity loss. But the adaptive molecules in Pennzoil Platinum® split into smaller pieces to slip through high shear areas, reforming as soon as they are out of harm's way.

PENNZOIL

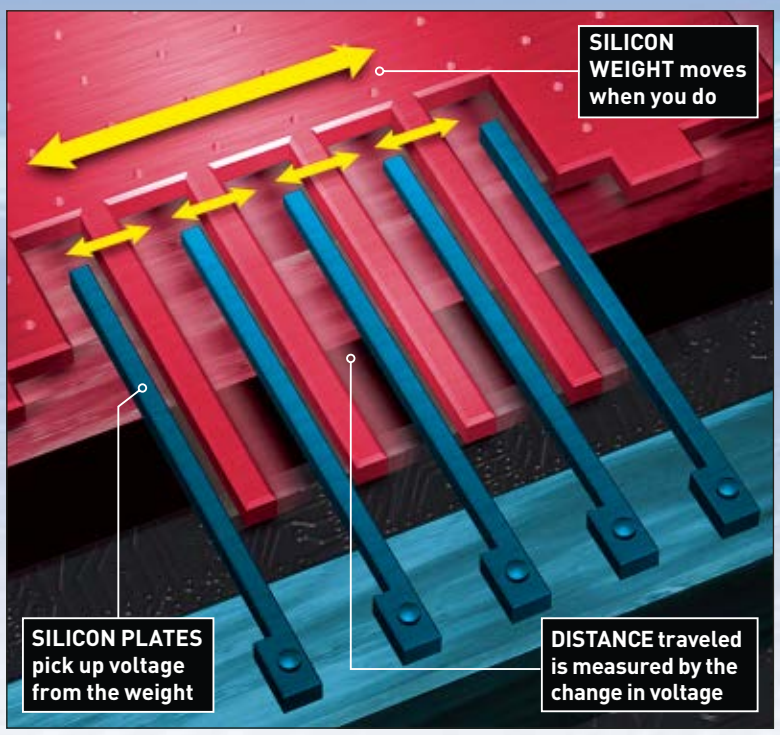
PennzoilPlatinum.com

THE Wii'S WILD CONTROLLER

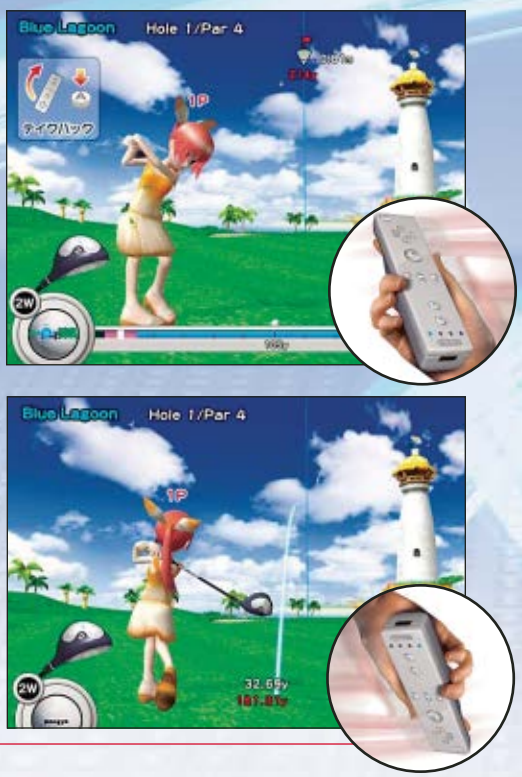
How does your Nintendo know if you're swinging like Tiger or flailing like a duffer? With accelerometers that measure distances narrower than a human hair

BY LAUREN AARONSON

WHAT HAPPENS WHEN YOU SWING



WHAT YOU SEE



THE DETAILS

1. THE SETUP

An accelerometer consists of a **silicon weight**—less than one millionth of a gram—connected to a chip by minuscule springs. When you hold the controller still, the weight sits equidistant between sets of **silicon plates**. A current running through the weight sends equal voltages to all plates.

2. THE SWING

As you move your arm, the weight slides to one side, increasing the voltage at the nearer plates. The accelerometer measures this change in voltage and uses it to calculate the **distance** the weight has traveled—a matter of no more than five nanometers (a hair is around 200 nanometers wide).

3. THE PHYSICS

A basic law—force divided by mass—yields the acceleration. The force depends on the distance the weight moves and the stiffness of the springs holding it. With weights that shift up and down, left and right, and back and forth, the accelerometer measures movement in three dimensions.

4. THE ACE

The controller wirelessly sends data about your movement to the main console, which compares your actions with a database of possible swings. If you swing smoothly with a straight follow-through, it corresponds to a perfect shot, and you're headed for a hole-in-one.

THIS PAGE: ILLUSTRATIONS: KEVIN HAND; SCREENSHOTS: COURTESY TECMO, INC.; FACING PAGE, CLOCKWISE FROM LEFT: SATOSHI; DIGITAL IMAGING: ERIC HEINTZ; COURTESY VOLVO; COURTESY WHIRLPOOL; COURTESY LENOVO; COURTESY CANON USA; COURTESY NIKE

HOW DOES IT KNOW WHERE YOU'RE POINTING?
When infrared light beamed from the controller hits a sensor strip placed above or below your TV, the Wii registers the controller's exact position. As you move, the accelerometer tracks how it's shifted relative to that spot, so the Wii can determine precisely what you're aiming at.

DVD DRIVE

SPEAKER

NUNCHUCK, a secondary controller, also uses an accelerometer

CONTROLLER, with accelerometer on the back side of the board

MORE PLACES YOU'LL FIND ACCELEROMETERS

AIRBAGS



To trigger airbags, an accelerometer sits near the gearshift, where its central position lets it accurately judge a car's motion. With stiff springs, it reacts only to major, sudden changes in speed.

WASHING MACHINES



To spin efficiently and rumble-free, some washers assess vibration with an accelerometer near the motor. The machine will opt for the speed that produces the fewest shudders.

LAPTOPS



If a hard drive's writing arm scratches the platter that holds data, the drive is toast. In many new laptops, an accelerometer detects a fall and tells the hard disk to park its arm safely in non-write mode before the computer hits the ground.

CAMERAS



Image stabilization relies on accelerometers near the lenses to sense side-to-side and up-and-down jiggles. A motor in the lens array shifts the image in the opposite direction to counteract shakes.

PEDOMETERS



An accelerometer attached to a shoe measures the forward distance covered with each step, marked by the up-and-down movement of your leg. By adding up the strides, it computes your total distance.

SWAT'S NEW GUN

Cops carrying the Sig 556, one of the most accurate and reliable automatic rifles ever built, can consistently hit targets only a few inches across from 400 yards away. Here's a peek inside the complex mechanical routine that fires each bullet BY ERIC ADAMS

PHOTOGRAPHS BY JOHN B. CARNETT



SIGARMS SIG 556

TYPE: Gas-operated fully or semiautomatic rifle
ROUNDS PER MINUTE: 900
LENGTH: 37 inches
WEIGHT: 7.8 pounds
MORE INFO: *sigarms.com*

THE DETAILS

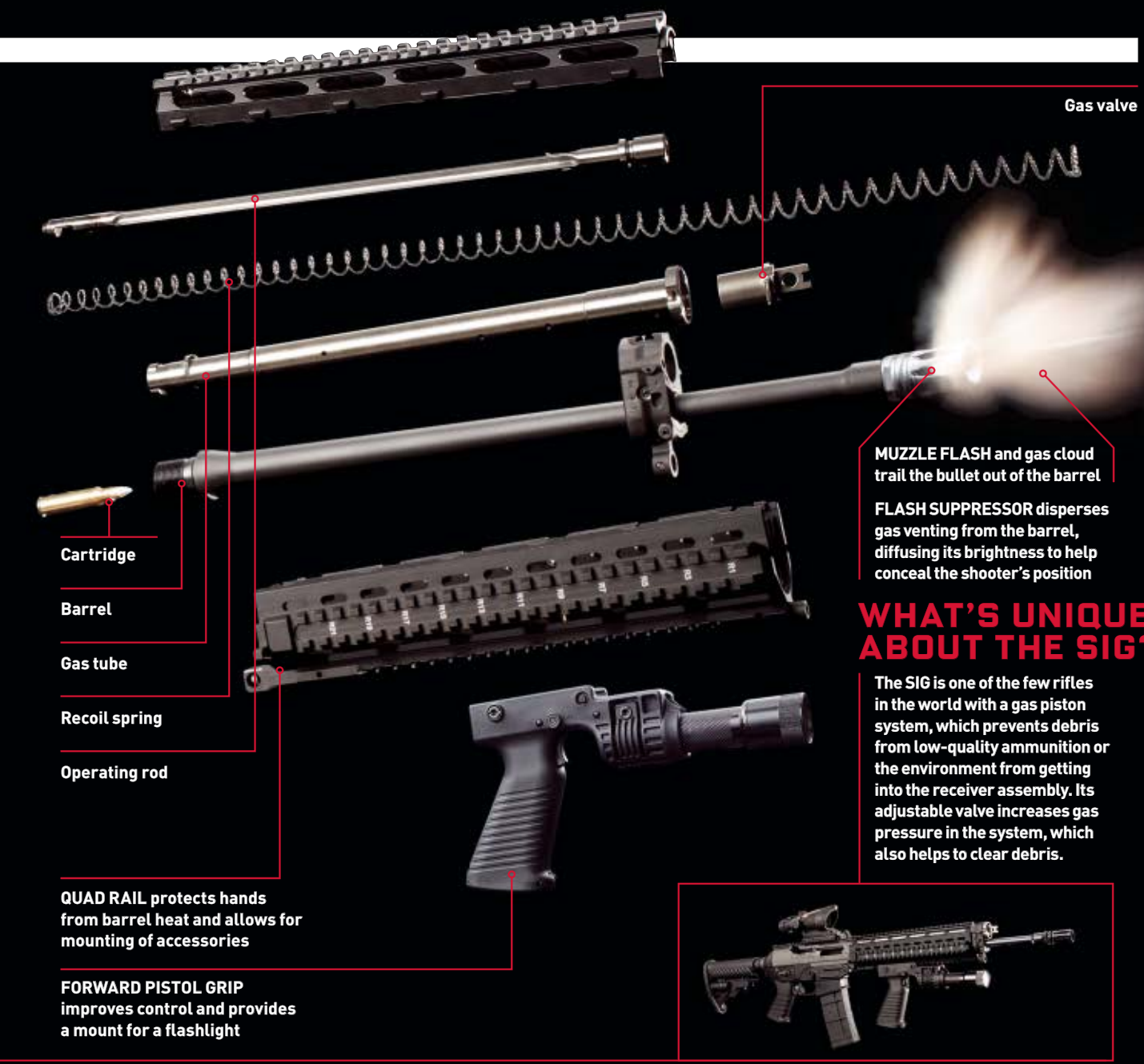
WHAT HAPPENS WHEN YOU FIRE?

1. The shooter pulls the two-stage trigger, which releases a spring-loaded **hammer**. The first stage is a resistance point, the second fires. Less motion to fire helps the shooter precisely gauge when the shot will go off.

2. The hammer strikes a **firing pin**, which rams the back of the bullet that's in the chamber—in this case, a 5.56 NATO (.223-caliber) **cartridge**, a common, inexpensive round for hunting, military and police purposes.

3. The impact ignites a chemical mixture—called a priming compound—inside the **cartridge**, causing the gunpowder to burn rapidly and increasing pressure inside the cartridge until it forces the bullet down the **barrel**.

4. High-pressure gas from the burned gunpowder vents through a hole in the top of the barrel, through the **gas valve** and into the **gas tube**.



WHAT'S UNIQUE ABOUT THE SIG?

The SIG is one of the few rifles in the world with a gas piston system, which prevents debris from low-quality ammunition or the environment from getting into the receiver assembly. Its adjustable valve increases gas pressure in the system, which also helps to clear debris.

5. The gas pushes the **operating rod** rearward, which in turn forces the **bolt carrier** backward. This rotates and unlocks the **bolt head** from the **receiver** so the spent cartridge can be ejected and replaced with a fresh round.

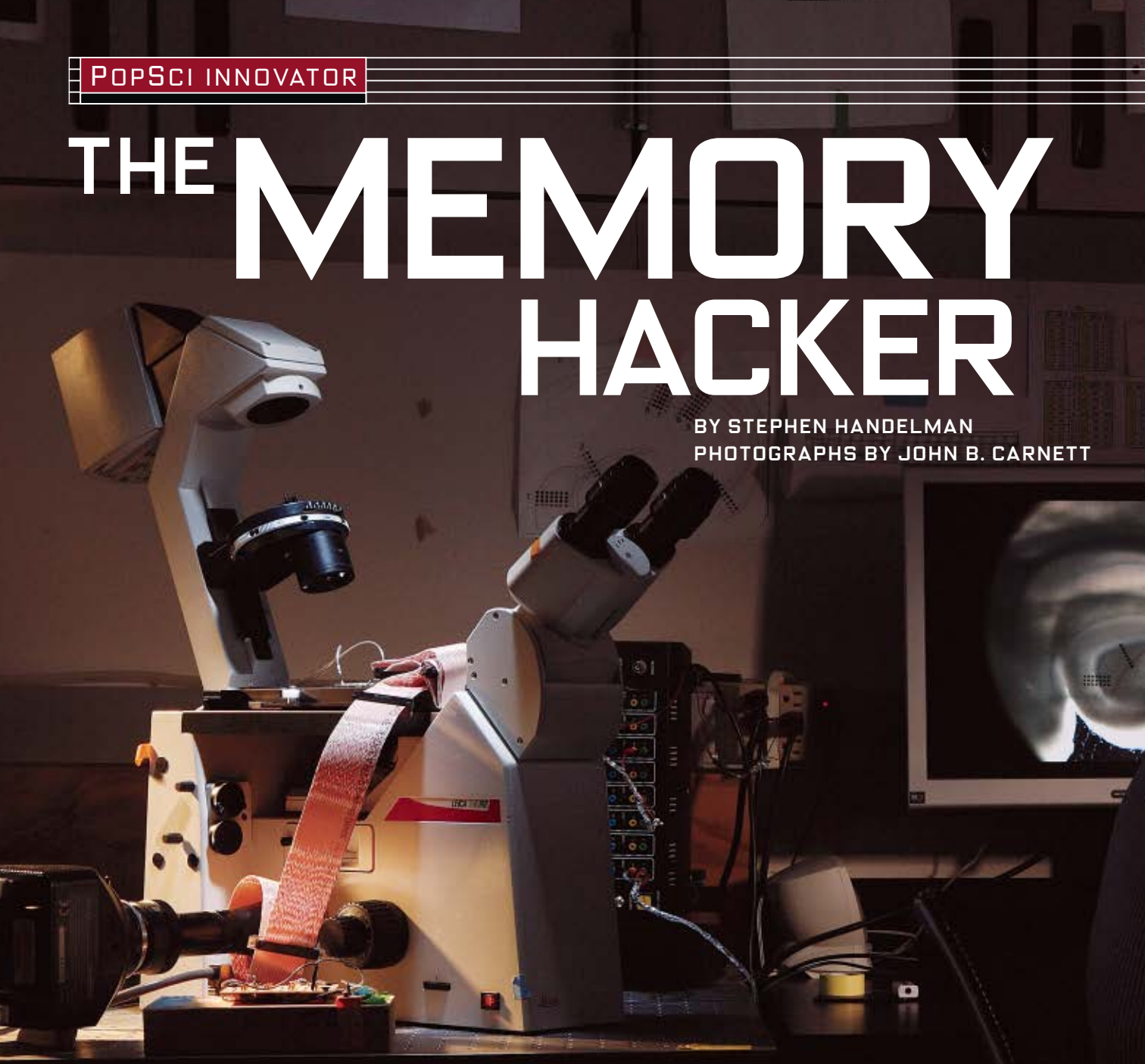
6. As the bolt carrier moves backward, the extractor locks onto the rim of the spent cartridge and pulls it against the ejector (a small protrusion inside the receiver), which hurls the case out of the receiver. The same rearward motion also recocks the hammer.

7. A **recoil spring** in the gas tube brings the operating rod back to its firing position, driving the bolt back. The bolt pushes another bullet from the magazine and slides it into place for the next shot. A cam rotates the bolt head to lock and seal the cartridge in the chamber.

8. If the rifle has a fully automatic mode—civilian target-shooting versions do not—a single squeeze of the trigger allows this process to repeat uninterrupted, at up to 900 rounds a minute, until the bullets are gone.

THE MEMORY HACKER

BY STEPHEN HANDELMAN
PHOTOGRAPHS BY JOHN B. CARNETT



Ted Berger has spent the past decade engineering a brain implant that can re-create thoughts. The chip could remedy everything from Alzheimer's to absent-mindedness—and reduce memory loss to nothing more than a computer glitch

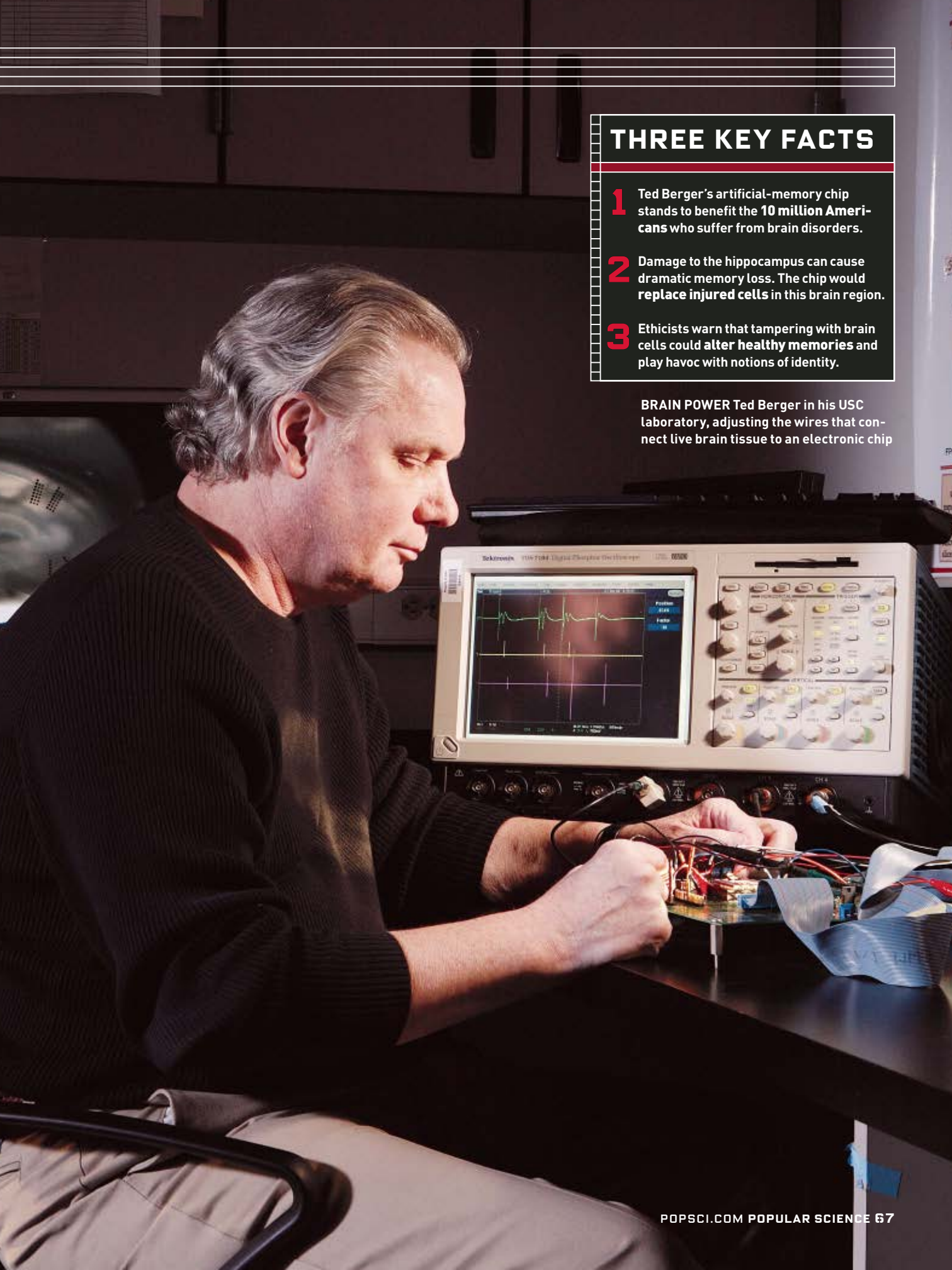
IN WET LAB 412C on the University of Southern California's Los Angeles campus, Vijay Srinivasan is poking a long, evil-looking needle at a slice of rat brain about half the size of a fingernail. All around him, coils of cable are piled near hulking microscopes. Glass vials and fluid-filled plastic dishes compete for space with spare keyboards and computer chips. The place looks more like a computer-repair shop than a world-class laboratory.

"Watch this," says Srinivasan, a design engineer working with USC's Center for Neural Engineering. A thin wire runs between the needle and a tiny silicon chip hooked up to a boxy signal transmitter. He flips a switch, and a series of small waves shimmers across a nearby screen—waves that mean exactly zilch to me. Watch what? I wonder.

Srinivasan explains that the chip is sending electric pulses through the needle into the brain slice, which is passing them on to the screen we're watching. "The difference in the waves' modulation reflects the signals sent out by the brain slice," he

THREE KEY FACTS

1. Ted Berger's artificial-memory chip stands to benefit the **10 million Americans** who suffer from brain disorders.
2. Damage to the hippocampus can cause dramatic memory loss. The chip would **replace injured cells** in this brain region.
3. Ethicists warn that tampering with brain cells could **alter healthy memories** and play havoc with notions of identity.



BRAIN POWER Ted Berger in his USC laboratory, adjusting the wires that connect live brain tissue to an electronic chip

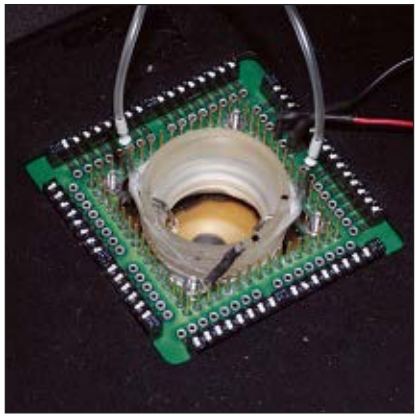
says. "And they're almost identical in frequency and pattern to the pulses sent by the chip." Put more simply, this iron-gray wafer about a millimeter square is talking to living brain cells as though it were an actual body part.

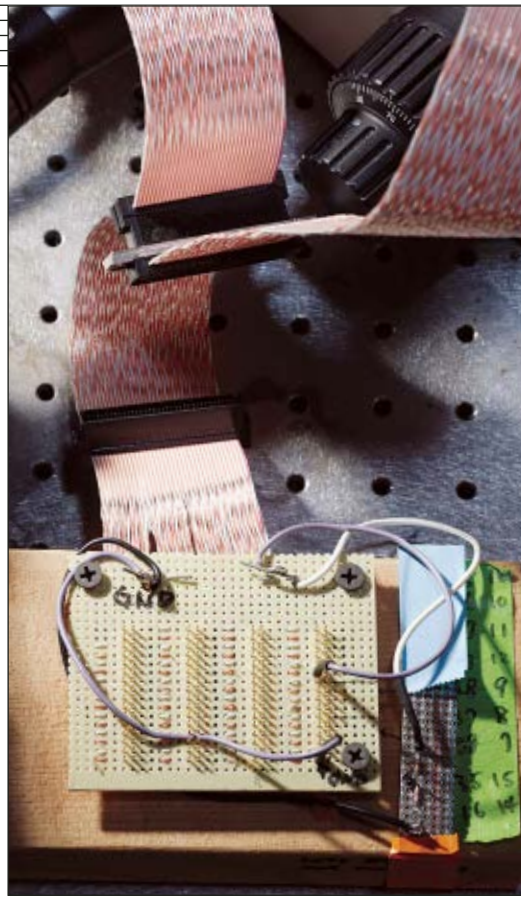
Ted Berger, Srinivasan's boss and the mastermind behind the tangle of coils and electrodes, has arranged this demonstration to provide a small but profound glimpse into the future of brain science. The chip's ability to converse with live cells is a dramatic first step, he believes, toward an implantable machine that fluently speaks the language of the brain—a machine that could restore memories in people with brain damage or help them make new ones.

Remedying Alzheimer's disease would, if Berger's grand vision plays out, be as simple as upgrading a bit of hardware. No more complicated drug regimens with their frustrating side effects. A surgeon simply implants a few computerized brain cells, and the problem is solved.

Down the hall, Berger rises to greet me in his office. An imposing man with a shock of gray hair, Berger, 56, has the thick build of an aging athlete and the no-nonsense manner of a CEO. Can a chunk of silicon really stand in for brain cells? I ask. "I don't need a grand theory of the mind to fix what is essentially a signal-processing problem," he says. "A repairman doesn't need to understand music to fix your broken CD player."

What the chip is saying is anyone's guess—the content of the conversation is beside the point, Berger continues. It's straight mechanic-talk from the man who has created a prototype of the world's first memory implant, basically a hardware version of the brain cells in your hippocampus that are crucial to the formation of memory. The chip is meant to replace damaged neurons in the same way other prosthetic devices stand in for missing limbs or improve hearing. "If we can mimic even 10 percent of the brain's efficiency and power, it would be humongous," Srinivasan tells me later.





THINKING INSIDE THE BOX The quest to restore damaged cognitive functions with electronic parts begins with a small dish of living rat brains [above], located inside a lab at the University of Southern California. In this experiment, an electrode sends a pulse of electricity through a sliver of damaged tissue. A second electrode intercepts and reroutes the signal over the injured area to a circuit board [right]. There, the signal is processed and sent back to the tissue.

Berger's research team—an all-star roster of neuroscientists, mathematicians, computer engineers and bioengineers from around the country—has so far managed to reproduce only a minute amount of brain activity. Their chip models fewer than 12,000 neurons, compared with the 100 billion or so present in a human brain. Yet researchers within the field say that even this small number represents a stunning achievement in the field of neuro-engineering. "It's the type of science that can change the world," says Richard H. Granger, Jr., a professor of brain sciences who leads the Neukom Institute for Interdisciplinary Computational Sciences at Dartmouth College. "Replicating memory is going to happen in our lifetimes, and that puts us on the edge of being able to understand how thought arises from tissue—in other words, to understand what consciousness really means."

FROM FRINGE TO VANGUARD

Berger walks me outside on this balmy late-summer afternoon and drives us down the Santa Monica Freeway in his lemon-yellow Jaguar convertible. We're on our way to USC's Information Sciences Institute at Marina del Ray, just 30 minutes south from Wet Lab 412C, where computer programmers have been helping Berger fine-tune his chip. The big challenge, Berger says as he guns ahead of an 18-wheeler, is to make the chip fully bidirectional, so that it can both generate and receive signals, just like a real cell.

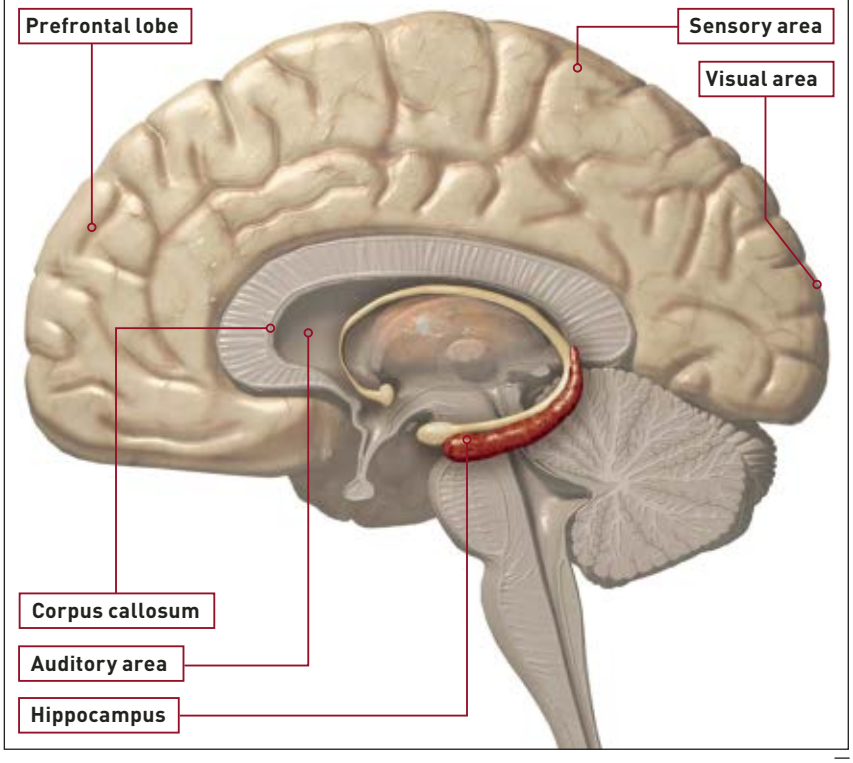
Berger's professorial monologue seems strangely at odds with his flashy style. The hair flying back from his temples, the designer shirt, the sports car—all this gives him the bearing of a dot-com millionaire, not a researcher who spends his days thinking about rat brains. "To be honest," he says, "the general reaction to what we're doing is: Wow, this is really cool, but you guys are nuts."

Berger has grown accustomed to this reputation. He has spent most of his career on the fringe of his field, only to watch that fringe become the leading edge in recent years. As a young Har-



ANATOMY OF A MEMORY

The hippocampus is part of the brain's central processing center. It helps analyze sight, sound, taste, smell and touch and stores the data as memories.



MOST SCIENTISTS REGARDED THE BRAIN AS A POORLY UNDERSTOOD SWAMP OF BIOCHEMICAL SIGNALS. BERGER SET OUT TO REDUCE HIGHER COGNITIVE FUNCTIONS TO A SIMPLE SET OF MATHEMATICAL EQUATIONS.

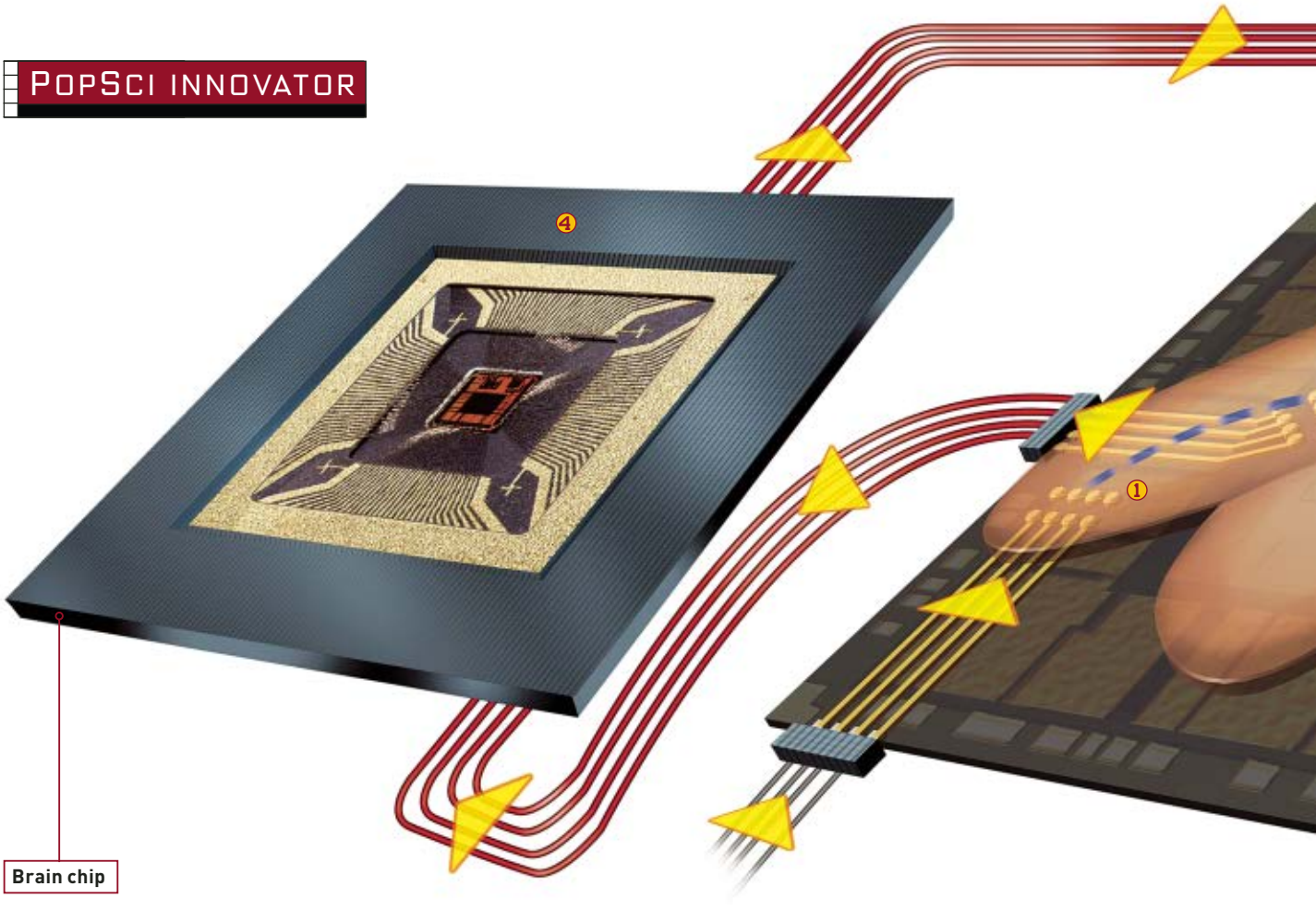
vard graduate student in physiological psychology in the 1970s, he published a now-classic study of eye-blinking in the prestigious journal *Science* that established him as an oddball wunderkind in the competitive field of neuroscience. By the time he earned his Ph.D. in 1976, at the age of 26, he had accumulated 10 papers and an award from the New York Academy of Sciences. But as he ascended the ranks of academia, he grew increasingly restless with the accepted wisdom of his colleagues. "The idea was that you could solve every brain problem with a drug or surgery," Berger remembers. He began to chart a different path in the 1980s.

At the time, most neuroscientists largely regarded the brain as a poorly understood swamp of biochemical interactions. Berger, however, set out to reduce higher cognitive functions to a set of mathematical equations based on how neurons responded to various stimuli—equations that could then be coded into some form of prosthetic device. Even in casual conversation, Berger seems eager to demystify the brain. "Its cells are nothing but leaky bags of salt solution, 20 microns in diameter," he says, laughing.

But beyond his professional ambition, it's the medical and therapeutic potential of neural chips that has most inspired Berger's singular vision. A machine able to revitalize memory cells would change the lives of millions of Americans who suffer from brain disease, and offer relief to the families that care for them. In 1999, that possibility became personally significant for Berger. At a time when he was keynoting conferences around the world, his mother suffered a stroke and developed strange neurological symptoms typical of hippocampal damage. "She didn't speak, but she could laugh and sing," recalls Berger, who grew up in Poughkeepsie, New York, the son of an electrical-engineer father. His mother's illness and resulting death in 2005 had a profound and grounding influence on his work. "It suddenly made my research more than just a cool laboratory problem to solve," Berger says. "Instead of just thinking about [the brain chip] as solving one of the great puzzles of neuroscience, I now think mostly in terms of increasing the quality of life for stroke, epilepsy and dementia patients."

Today an estimated 4.5 million Americans suffer from Alzheimer's, at an annual cost of some $100 billion, according to the Alzheimer's Association and the National Institute on Aging. "And those figures are just going to climb as my generation gets older," says Berger, who can rattle off the grim statistics from Alzheimer's and other brain disorders that disturb memory. Another 5.3 million Americans are victims of traumatic brain injuries, which can trigger a variety of neurological dysfunctions affecting the hippocampus, including memory loss, epilepsy and Parkinson's disease.

Where Berger once had difficulty attracting research partners, his recent triumphs in the laboratory, coupled with the emerging medical potential of his work, have put him front and center. He now heads a National Science Foundation review panel on neuroprosthetics. As the leader of a national project investigating the brain-computer connection, he has attracted some of the country's most prominent scientists to his 65-member team. One of USC's top biomedical engineers, Vasilis Marmarelis, developed the modeling theory



for his chip, now being road-tested at the university's Los Angeles labs, where Berger directs the Center for Neural Engineering. And Sam Deadwyler, a national expert on pharmacology, will test the chip on the brains of live rats later this year at Wake Forest University. Berger is no longer on the fringe.

MELDING MIND AND MACHINE

Scientists' increasing ability to map the basic structure of the brain has already produced a handful of machine implants that can compensate for damaged sensory systems. The artificial cochlea, for instance, has given hearing to the deaf, and artificial retinas are now in patient trials.

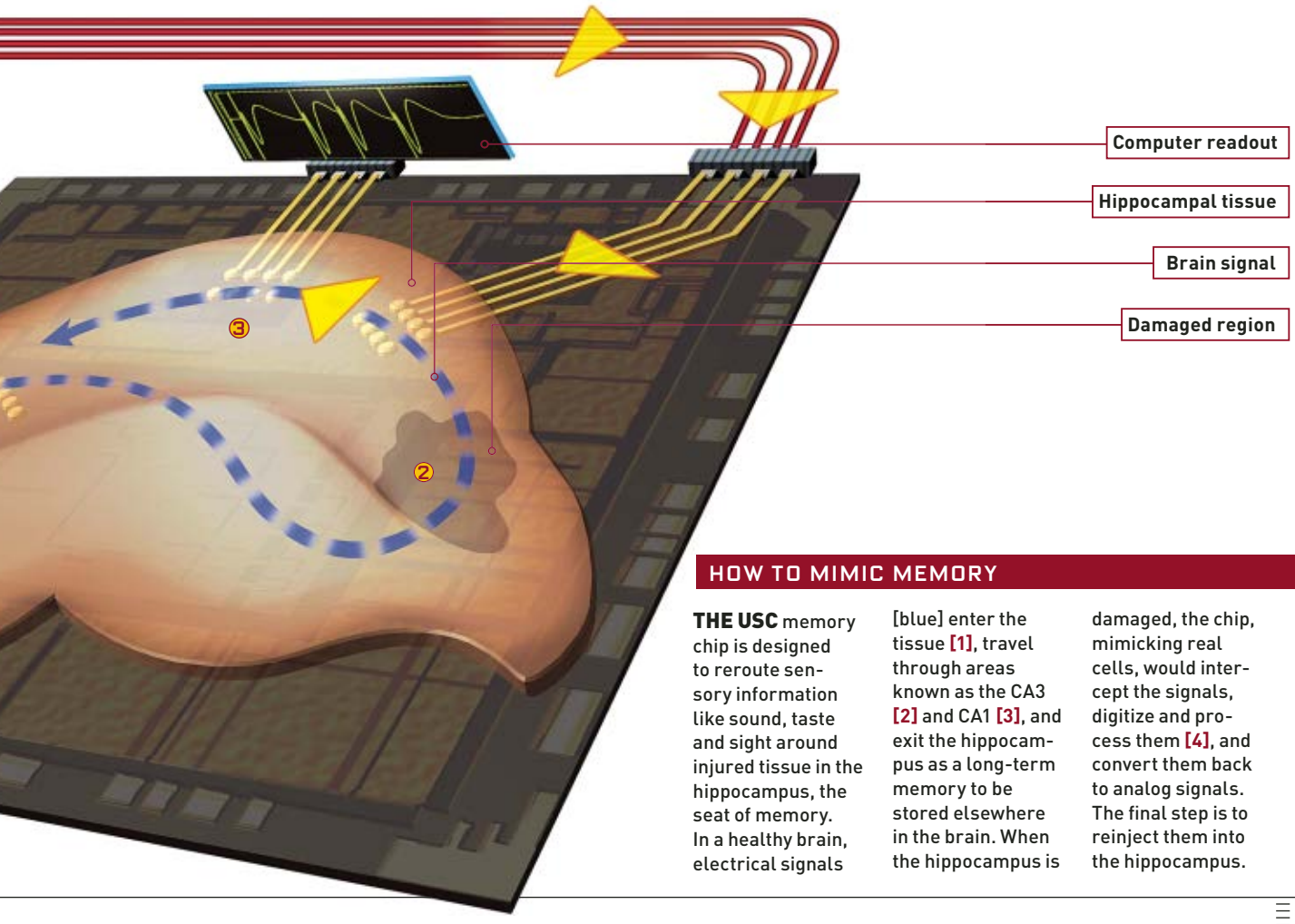
But the most dramatic achievement in humans so far is a neurosensor under development by brain researcher John Donoghue and his colleagues at Brown University. When placed over the brain's motor-cortex area, the sensor enables quadriplegics to open and close a prosthetic hand merely by thinking about doing it. This technology, called BrainGate, allows the machine to convert the electronic signals coming from the brain ("I want to move this hand") into motor activity by using algorithms embedded in a software chip. "The possibilities are limitless," says Elizabeth Razee of Cyberkinetics Neurotechnology Systems, a firm in Foxborough, Massachusetts, that hopes to bring BrainGate to market by 2009.

Cyberkinetics's work bears some similarity to Berger's. Both convert brain signals into code that can be interpreted and translated by a computer. But Berger has set himself the more difficult challenge. BrainGate offers a one-way link between mind and machine: The user can talk to a computer but not vice versa. Berger's brain chip operates in two directions, functioning as a bridge over damaged cells.

The challenge of mathematically mimicking brain function—and the internal language it uses to communicate concepts like emotion and memory—is complicated by the fact that brain cells converse in a sort of secret electrical code. One cell "talks" to another through pulses of electricity, the message of which depends on the time and frequency of their firing. These spatiotemporal patterns allow us to, for instance, gauge the distance between objects in a room and navigate around them.

Measuring these patterns, and programming the results in terms that a computer chip can understand, is what occupies John Granacki, a specialist in circuitry and part of Berger's interdisciplinary research team at the ISI in Marina del Ray. In the elevator on the way up to Granacki's office, Berger boasts, "These people are really cutting-edge. They're the ones who invented the Internet." (Actually, as Granacki later explains to me, they hosted the West Coast sector of Arpanet—the academic proto-Web—in the 1970s, but close enough.)

When we meet Granacki, he's clad in chinos and a starched button-down shirt. Rectangular, rimless glasses slide down his nose. No sooner do we sit down than he and Berger begin talking shop about chip production schedules and new math models.



HOW TO MIMIC MEMORY

THE USC memory chip is designed to reroute sensory information like sound, taste and sight around injured tissue in the hippocampus, the seat of memory. In a healthy brain, electrical signals [blue] enter the tissue [1], travel through areas known as the CA3 [2] and CA1 [3], and exit the hippocampus as a long-term memory to be stored elsewhere in the brain. When the hippocampus is damaged, the chip, mimicking real cells, would intercept the signals, digitize and process them [4], and convert them back to analog signals. The final step is to reinject them into the hippocampus.

"THEY TELL ME I DON'T KNOW WHAT MEMORY IS, WHICH IS TRUE," BERGER SAYS. "AND THEY ASK HOW I CAN REPLACE SOMETHING THAT I DON'T UNDERSTAND."

Suddenly I feel like the only one in the room who's speaking English.

For the past four years, Granacki has been trying to develop circuitry that could translate Berger's equations into electrical pulses. The big mechanical hurdle has been figuring out a way to reduce the amount of heat generated by the transistors so that a chip won't damage healthy brain cells. The solution was to create a more complex version of the same kind of digital circuit that performs computations for a family desktop, except far smaller.

Jeff LaCoss, the senior electrical engineer on Granacki's team, hands me a working model of the memory chip. Similar to the one I witnessed at Wet Lab 412C and lighter than a feather, it disappears in my palm. The chip, LaCoss tells me, represents 100 neurons that can individually receive analog signals from live brain tissue, convert them to digital signals, and then reconvert them to an analog signal relayed to healthy neurons on the other side. "We still need to do some tinkering," cautions LaCoss, stealing a glance at his boss. "But I'd say it's just about ready to go."

LESS THINKING, MORE DOING

For all their lofty ambitions and recent progress, Berger and his team still don't understand how the brain processes and sorts information any better than other neuroscientists do—one reason, he admits, why many of them have criticized his work. "They tell me I don't know what memory is, which is true," he says, walking with me toward the parking lot. "And they ask how I can replace something that I don't understand."

Berger's answer is simple: Just by doing it. Later this year, Berger's colleagues at Wake Forest will hook up a more complex version of the chip to live lab rats whose memories have been temporarily disabled by drugs. If the animals' brains react to the computer-supplied signals with the same regularity as the slice of rat brain in Wet Lab 412C does, it will, Berger says, be a "monumental" moment. "We'll prove we can replace a central part of the brain that has lost a higher cognitive function, such as memory, with a microchip," he says.

Within four years, the team aims to wire a chip beneath the skulls of monkeys, whose brains are even closer to humans. Berger predicts that human trials of a prosthetic device that can actually replace impaired memory

(CONTINUED ON PAGE 96)

STUDIES SUGGEST HEADLINES ARE BAD FOR YOU

Health "news" is often more mindless hype than balanced science. How much more? To find out, we dug into the research behind some recent headlines BY JASON DALEY



CHEERS! SCIENTISTS SAY RED WINE STOPS YOU GROWING OLD

The Express (U.K.), November 2, 2006

THE STUDY "Resveratrol Improves Health and Survival of Mice on a High-Calorie Diet," *Nature*, 2006

THE HYPED FINDINGS The media anointed a new wonder drug when this Harvard Medical School study showed that resveratrol, a compound found in red wine, not only gave overweight mice the energy of their normal-size brethren, it extended their life span by about 20 percent.

THE SUBTLER TRUTH "We weren't looking for a red-wine connection," says researcher Joseph Baur. "It's just a coincidence that the molecule happened to be in red wine." Regardless, the study's resveratrol dosages were far greater than man or mouse could absorb from wine alone. By one estimate, a person would have to drink 750 bottles or more *daily* to get the equivalent amount of resveratrol administered to the mice.

THE BOTTOM LINE Red wine doesn't have enough resveratrol to give humans any health benefit, nor do we know that its effects on mice would be seen in people.

PIZZA PACKS ANTI-CANCER PUNCH

Connecticut Post (Bridgeport, Conn.), July 21, 2003

THE STUDY "Does Pizza Protect against Cancer?" *International Journal of Cancer*, 2003

THE HYPED FINDINGS According to the study's lead author, Silvano Gallus of the Mario Negri Institute for Pharmaceutical Research in Milan, Italy, the answer is a resounding "Sì!"—at least when it comes to cancers of the digestive tract. Gallus and his co-authors reviewed the case histories of 4,999 Italians who did not develop cancer and 3,315 who did, and concluded that eating pizza once a week is a "favorable indicator" in preventing esophageal, oral, colon and rectal cancer.

THE SUBTLER TRUTH Italian pizza, typically made with olive oil, fresh tomatoes and slices of pure mozzarella, is very different from the pepperoni-and-processed-cheese gut bombs Americans devour. Most likely, the research simply indicates that Italian pizza-eaters partake in a more traditional, healthier Mediterranean diet than non-eaters.

THE BOTTOM LINE Gallus's understated take: "If you repeat the same study in the USA, probably you will obtain different results."

THE PUB IS BETTER FOR YOU THAN THE GYM

The Sun (U.K.), June 22, 2006

THE STUDY Unpublished research, John Folts, University of Wisconsin; presented at the 2003 American Heart Association Annual Convention

THE HYPED FINDINGS The posters and their health claims were banned decades ago, but researchers at the University of Wisconsin have concluded that Guinness may be good for you after all, or at least better than lager. After injecting eight dogs with either Guinness Extra Stout or Heineken, researcher John Folts found that the beloved "steak in a glass" was three times as effective as the lighter beer in preventing blood platelets from clotting, most likely, he says, because of its high concentration of antioxidant flavonoids.

THE SUBTLER TRUTH The medical effects of flavonoids in humans are unproved. What is known is that alcohol causes liver damage. In any case, flavonoids are also present in fruits and vegetables, an undoubtedly legitimate part of a healthy diet.

THE BOTTOM LINE Beer is not a health elixir.

MACDUFF EVERTON/CORBIS (PUB); NICK DOLDING/CORBIS (BODYBUILDER); SUPERSTOCK (BARREL)



IS GUINNESS GOOD FOR YOU? If you want to treat your heart well, go to the gym, not a bar.



THE WAY TO A GIRL'S HEART? Chocolate's good qualities may extend beyond the romantic.

CHOCOLATE'S BETTER THAN BROCCOLI

Newsday (New York), October 30, 2006

THE STUDY "Chocolate and Prevention of Cardiovascular Disease: A Systematic Review," *Nutrition & Metabolism*, 2006

THE HYPED FINDINGS Researchers at the Harvard School of Public Health found that the flavonoids in chocolate, like similar compounds in red wine and grape juice, may protect the cardiovascular system.

THE SUBTLER TRUTH Most of the benefits the study found in chocolate—high-cocoa-content dark chocolate, by the way, not the sugary candy-aisle variety—were extrapolated from short-term trials. Long-term, randomized trials are needed to confirm the connection to a healthy heart.

THE BOTTOM LINE Enjoy chocolate in moderation, but don't imagine that it's a health food the way green leafy veggies are.

ARE YOU DRINKING ENOUGH COFFEE? GET HEALTH UP TO SPEED

The Commercial Appeal (Memphis, Tenn.), October 9, 2006

THE STUDY "Coffee Consumption and Risk of Type 2 Diabetes," *Journal of the American Medical Association*, 2005

THE HYPED FINDINGS This Harvard analysis of 15 studies concluded that coffee can slash the risk of Type 2 diabetes by a third.

THE SUBTLER TRUTH Two mugs a day don't cut it. The full benefit requires six or seven cups (decaf works too).

THE BOTTOM LINE Common sense rules: overdosing on caffeine isn't the best way to lower your diabetes risk.

VIDEO GAMES FILL PSYCHOLOGICAL NEED

CBC News (Canada), December 27, 2006

THE STUDY "The Motivational Pull of Video Games: A Self-Determination Theory Approach," *Motivation and Emotion*, 2006

THE HYPED FINDINGS In this study, researchers at the University of Rochester tried to determine how videogames affect players' feelings of well-being, self-esteem and satisfaction. To that end, they asked 200 college students to play *Super Mario 64*, *Super Smash Brothers* and other Nintendo 64 games and discovered that, at least in the short term, games could give players a sense of accomplishment and improve their feelings of "psychological wellness."

THE SUBTLER TRUTH Those good feelings, as the researchers wrote, are "the same basic motivators that other forms of entertainment, such as sports, contain." Plus, the games caused fatigue, or "reduced vitality." The study's summary: "It may be premature to conclude that computer gaming is negatively related to well-being"—in other words, we're not yet sure that they're bad.

THE BOTTOM LINE Videogames may give a temporary self-esteem boost, but so do countless real-world activities.

PHOTOGRAPHS: THIS PAGE: NEIL BECKERMAN/GETTY IMAGES (MAIN); NICHOLAS EVELEIGH/GETTY IMAGES (CHOCOLATE BAR); FACING PAGE: COURTESY LUCASFILM



HE GOT THIS RIGHT: "Fear is the path to the dark side."

WRONG WAS YODA: ANGER IS GOOD

The Toronto Star, November 27, 2005

THE STUDY "Facial Expressions of Emotion Reveal Neuroendocrine and Cardiovascular Stress Responses," *Biological Psychiatry*, 2007

THE HYPED FINDINGS How would you feel if someone taunted you while you were trying to count backward from 6,233 by 13s? Yeah, you might get a little angry, and so did many of the 92 participants in this Carnegie Mellon University study. Others, though, responded to the mocking with fear rather than anger. By watching people's faces and measuring their cortisol levels, lead author Jennifer Lerner found that the subjects who expressed anger and frustration during the exercise released less of the stress hormone than those who were afraid of screwing up.

THE SUBTLER TRUTH The findings indicate that getting mad for a moment or two when the guy in the Lexus cuts you off won't spike stress levels as much as reacting with fear—and is thus healthier. But that isn't to say that being an angry person is the path to enlightenment.

THE BOTTOM LINE It's OK to let it out every once in a while. But consistently being angry, which has been implicated in cardiovascular disease, is in no way a good thing.

Writer Jason Daley consumes exactly one six-ounce glass of red wine per day.

HOUSEWORK CUTS CANCER

Weekend Australian, December 30, 2006

THE STUDY "Physical Activity and Breast Cancer Risk: The European Prospective Investigation into Cancer and Nutrition," *Cancer Epidemiology Biomarkers & Prevention*, 2007

THE HYPED FINDINGS This study looked at 218,000 European women between the ages of 20 and 80 and found that increased household activity seemed to reduce the risk of breast cancer among middle-aged and older women.

THE SUBTLER TRUTH The researchers didn't unravel whether housework was any less effective than frequent, intense exercise like running. The reason? Even with 218,000 women in the study, too few exercised with enough vigor to tease a definitive result out of the statistics.

THE BOTTOM LINE Don't trade in your Nikes for a Swiffer just yet. Exercise is exercise, and—guess what?—it's good for you.

WE PAY WHEN WE SHUN THE SUN

The Kansas City Star (Missouri), June 6, 2006

THE STUDY "Sun Exposure and Mortality from Melanoma," *Journal of the National Cancer Institute*, 2005

THE HYPED FINDINGS This study of more than 500 patients with melanoma—one of the most serious forms of skin cancer—found a positive correlation between sun exposure and survival rates. The idea is that vitamin D, produced by the skin when exposed to sunlight, helps keep disease in check.

THE SUBTLER TRUTH We haven't spent years arming ourselves with umbrellas and Kabuki-style face paint at the beach for nothing. Yes, a little unprotected sun exposure is probably a good idea, but this study isn't carte blanche to rub on the cocoa butter and begin roasting yourself.

THE BOTTOM LINE Sunburns are still the primary cause of skin cancer. Avoid them.

Skills of the Skeptics

Four ways to avoid jumping on a junk-science bandwagon

1 READ DEEPER
To understand the real science behind the headlines, find the journal article cited. Consider the reputation of the journal and the article's authors, as well as where the study's funding originated, before you start believing.

2 TRUST YOUR INSTINCTS
Just because a scientist believes his or her own research doesn't mean you should. Think critically about a paper's conclusions, which sometimes don't follow logically from the study's observations.

3 CHECK THE DOSAGE
Some "miracle foods" must be eaten in inhuman amounts to confer any benefits. And context matters. Don't mistake a whole food for a single beneficial compound or chemical that it contains—or vice versa.

4 DELAY ACTION
It usually takes years of laboratory work and follow-up studies to confirm a health claim. Don't change your diet or behavior over one story. Instead, wait for the evidence to pile up.

You spend 1/3 of your life in bed.

Isn't it worth investing in the perfect mattress?

Why is it that we spend more time researching a car we're going to drive a few hours a week than we do a bed where we spend a third of our lives? Especially when the amount and quality of our sleep directly impacts our physical and mental health.



Tempur-Pedic's Weightless Sleep™ Technology delivers unparalleled comfort.

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Each Tempur-Pedic Swedish Mattress™ contains billions of viscoelastic cells that gently settle to support every contour of your body. The mattress molds itself to your body shape, taking pressure off of your neck, back, shoulders and hips. You'll feel like you're sleeping on a cloud because every part of your body receives complete and relaxing support. Recent research even indicates that Tempur-Pedic beds reduce nighttime tossing and turning by more than 70%.

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HOW 2.0

TIPS, TRICKS, HACKS AND DO-IT-YOURSELF PROJECTS



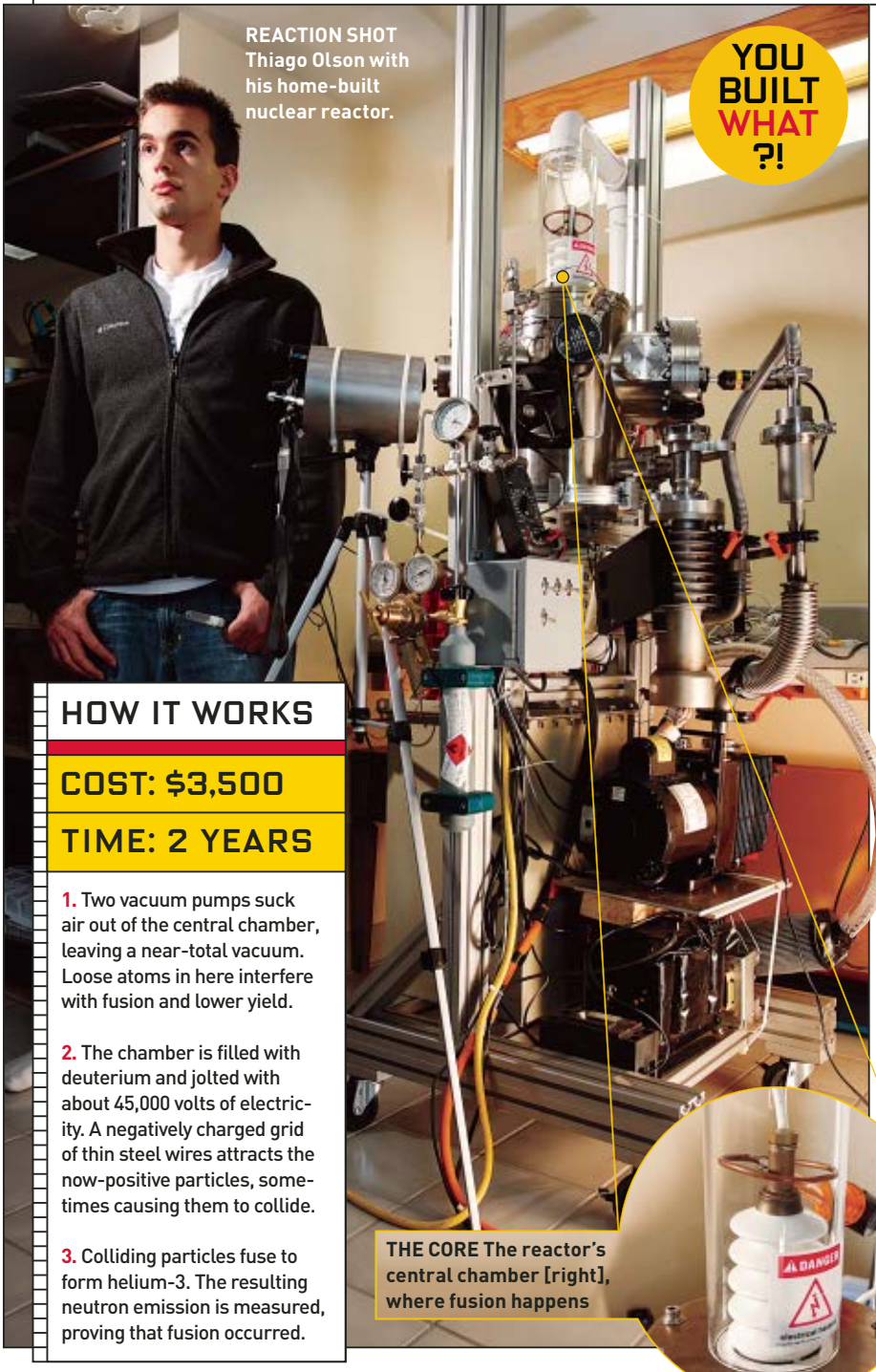
78
Build an old-school arcade table



80
Make better use of your Zune MP3 player



89
Clean the floor with a radio-controlled car



REACTION SHOT Thiago Olson with his home-built nuclear reactor.

YOU BUILT WHAT ?!

JOHN B. CARNETT

HOW IT WORKS

COST: $3,500

TIME: 2 YEARS

1. Two vacuum pumps suck air out of the central chamber, leaving a near-total vacuum. Loose atoms in here interfere with fusion and lower yield.

2. The chamber is filled with deuterium and jolted with about 45,000 volts of electricity. A negatively charged grid of thin steel wires attracts the now-positive particles, sometimes causing them to collide.

3. Colliding particles fuse to form helium-3. The resulting neutron emission is measured, proving that fusion occurred.

THE CORE The reactor's central chamber [right], where fusion happens

KID FUSION

One high-school student's successful quest to create atomic energy, just for kicks

ITCHING FOR a challenging science project, two years ago Thiago Olson decided to build a small nuclear reactor. He had limited funds, limited space in his garage, and little engineering know-how. After all, he was only 15.

With a year of research and another of building, Olson pulled it off, joining a club of fewer than 20 amateurs in the world who are known to have created "fusors," tabletop machines that fuse atoms to produce energy. There's no risk of a mushroom cloud—the machine creates barely enough energy to heat a cup of coffee, and radiation officials in Michigan (where Olson lives) have already deemed it safe.

How did he do it? Olson pored over graduate-level physics textbooks, studied vacuum-pump manufacturers' manuals, and scoured the Web for cheap parts. Though mostly self-taught, he occasionally solicited advice on a fusion Web site. Once, he posted photos of a cheap photomultiplier tube he'd bought online because he had no idea how to rig it up. Another fusioneer on the site who had the same model promptly told him which wires went where. Amateur nuclear engineers are, it seems, a helpful bunch.

Now, his reactor up and running, Olson has turned to an even bigger challenge: college applications.

—GREGORY MONE



HEAVY METAL *Dig Dug* **is a favorite on the PopSci arcade table, which is 40 inches wide and weighs well over 200 pounds.**

BUILD IT

GAME ON

Free software lets any computer play hundreds of classic arcade games. So we loaded up an old PC and built a heavy-duty, tricked-out arcade table around it

DIG DUG, *Kung Fu*, *Ms. Pac-Man*. As nostalgia-inducing as the smell of Mom's cookies, the games that swallowed all your quarters as a kid are still out there, easily and cheaply played on any computer, thanks to a program known as Multiple Arcade Machine Emulator, or MAME. This application, which simulates the circuitry inside the old arcade games, lets your computer load just about any classic game file. A quick search will turn up hundreds of these ROMs, as they're called, on Web sites and in newsgroups, but since many are still copyrighted, downloading them from anyone other than their creator could be illegal. Fortunately, some companies now sell packs of legal ROMs, offering a dozen or more games for $20 and up. There are versions of MAME for any computer system (and even smartphones and PDAs), so you can simply play at your desk using your keyboard.

But for the real experience, you need a full-blown rig, complete with joysticks and buttons that can take a beating. It's easy to assemble and build one on your own [see parts list, facing page]. Get a head start at *arcadeinabox.com*, where you can buy kits, premade cabinets or just the basic plans. We used the plans as a guide for the PopSci gaming table [above and facing page], a perforated-steel work of alien-blasting art mounted on a set of 40-pound-bolt legs. Send us a picture of your creation at h20@time4.com, and we'll publish the best on *popsci.com*.—MIKE HANEY

WANT MORE GAMES?

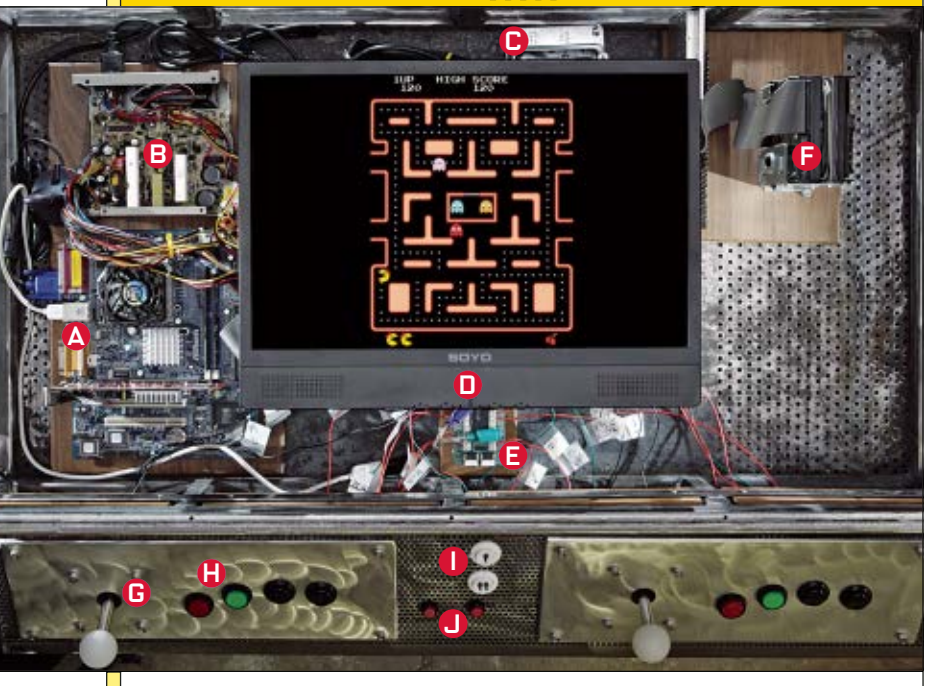
MAME ISN'T THE ONLY emulator out there. You can simulate just about any computer system or gaming console ever made, from Atari 2600 (*Pitfall!*, anyone?) to XBox. Check out *emulatorzone.com* for more info.

JOHN B. CARNETT

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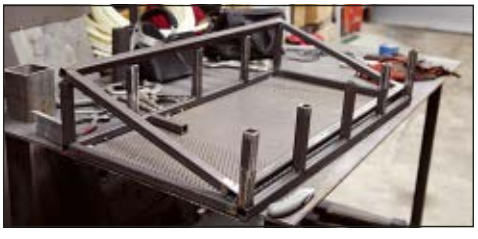


PARTS

A. Motherboard (free; salvaged)
B. Power supply (free; salvaged)
C. Panasonic slot-loading CD drive ($68; *meritline.com*)
D. Soyo 19-inch LCD ($130; *ecost.com*)
E. I-PAC control interface ($39; *ultimarc.com*)
F. 40-gigabyte hard drive (free; salvaged)
G. Two Ultimate Joysticks ($11.25 each; *www.happcontrols.com*) **with SlikStik illuminated replacement handles** ($30 each; *slikstik.com*)
H. Illuminated pushbuttons ($6.60 each; *www.happcontrols.com*)
I. One- and two-player buttons ($2.40 each; *www.happcontrols.com*)
J. Start buttons (91¢ each; *www.happcontrols.com*)

PLANS

1. Build an enclosure. Buy plans ($20) from *arcadeinabox.com*, or start from scratch.
2. Install the monitor and computer parts inside; be sure to keep the fans and allow for ventilation.
3. Mount the joysticks and four to eight buttons, depending on the games you plan to play.
4. Solder wires from the controls to the connections on the I-PAC control interface. Plug the I-PAC into a USB port on the computer.
5. Go to *mame.net* to download a version of MAME for your operating system.
6. Buy a pack of legal game ROMs from *arcadeinabox.com*.
7. Relive the glory.





STURDY BOX The enclosure's frame is made from one-inch channel steel. The legs are 40-pound, three-inch bolts with nuts that turn to level the table.

5 THINGS...

YOU CAN DO WITH YOUR GAME CONSOLE BESIDES PLAY GAMES

1 MAKE IT AN iPOD

Turn your Nintendo DS into a four-gigabyte impostor 'Pod with code from *forum.gbadev.org*. The software turns the DS's touchscreen into an iPod-like touch-wheel; track listings and other menus scroll on the top screen. Listen through the built-in speakers or the headphone jack.

2 REPLACE YOUR MOUSE

With the right software and a bit of scripting, the Nintendo Wii's motion-sensitive controller (the "Wiimote") can take over all the clicking and dragging on your computer. Learn how at *wiihacks.blogspot.com*.

3 AUTOMATE YOUR HOME

Change the channel, kill the lights, queue the music—*psphacks.blogspot.com* shows you how to teach your PlayStation Portable to direct just about any electronic equipment in the house using the PSP's built-in Wi-Fi and a home server.

4 GIVE YOUR PC HD

Play those new HD-DVD movies on your already HD-capable computer monitor by plucking the HD-DVD drive from Microsoft's Xbox 360 and dropping it into a PC. *Uneasysilence.com* walks you through the minor surgery, which, though not as easy as buying an off-the-shelf player, is cheaper.

5 GRILL STEAKS

The PlayStation 3 looks uncannily like a George Foreman grill. So hackers at *therealps3grill.com* turned the resemblance into reality, swapping Cell chips for heating coils. *Mortal Kombat* fans be warned: The culinary conversion completely torches your console's ability to run games.—ERIC MIKA

VOID YOUR WARRANTY

HACKING THE ZUNE

A few tweaks can turn Microsoft's MP3 player into the device it was supposed to be

UNTIL IT WENT ON SALE last November, Microsoft's Zune was heralded as the first true iPod-killer. But with its overly aggressive copyright protection and the odd, self-imposed limits to its most innovative features (like built-in Wi-Fi), it has so far failed to make even a dent in the iPod's shiny white-and-chrome armor. It's likely the Zune will improve with version 2.0 and beyond, but until then, here are three easy Zune tune-ups to ease the pain of waiting for a better model.—JOHN MAHONEY

UPGRADE THE HARD DRIVE

The Zune's 30-gigabyte drive could be a little roomier.

1. Buy an 80-gigabyte Toshiba drive ($160; *welovemacs.com*) or harvest an iPod's.

2. Open the Zune (see *ipodmods.com* for directions). Remove the battery, the hard-drive casing and the new drive's label plate, and install the new drive.

3. If you still don't love your Zune, at least hold on to the battery—as with the hard drive, you can use it as a spare for the latest video iPods.

USE IT FOR STORAGE

Unlike almost all other players, the Zune can't be used as a USB drive out of the box.

1. Install .NET Framework 2.0 from *microsoft.com*.

2. Download the ZuneHDPatch at *cppworld.com/Zune/ZuneHDPatch.exe*, and run it on your PC with your Zune unplugged and the Zune software closed.

3. Plug your Zune into your PC, and it should appear as an external hard drive.

4. To copy files, make sure the Zune software is running and set to "syncing."

KEEP SHARED SONGS

You can beam songs to other Zunes, but they are deleted after three plays.

1. To avoid this, do the storage trick [left], then change the song files' extension to .jpg. Place the files, along with a real image file, into a new folder in your Zune's "received pictures" folder (only non-copyrighted songs!).

2. Send the "pictures" folder to a friend's Zune.

3. On that Zune, sync the folder with a PC. Change the extensions back, and move the songs to your Zune.

MORE TRICKS

WATCH YOUTUBE

Use the Internet Explorer add-on ZuneMyTube (*tinyurl.com/y2oomb*) to download videos automatically.

FREE UP YOUR MUSIC

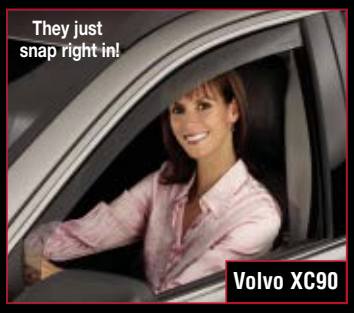
Go to Options > Rip > Format > MP3 to set your Zune software to encode files in MP3 format instead of Microsoft's WMA so you can still play your songs if you pawn your Zune for an iPod.

LUIS BRUNO; BACKGROUND: CHAD BAKER/GETTY IMAGES

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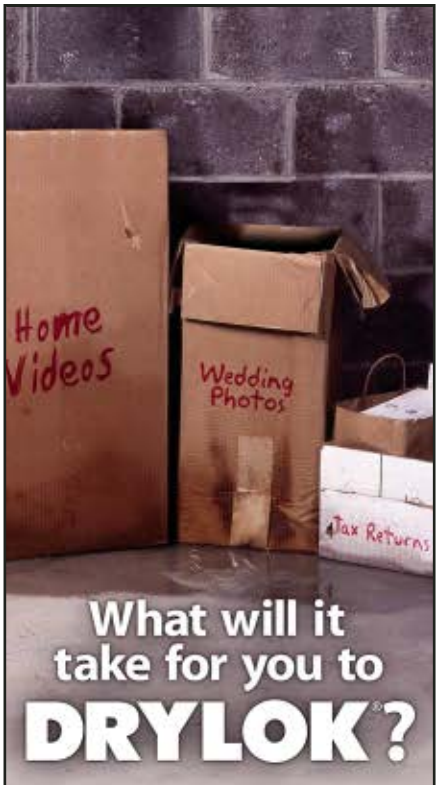
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H2WHOA! These mods are not authorized by Microsoft and could void your warranty, damage your device, or violate copyright laws.





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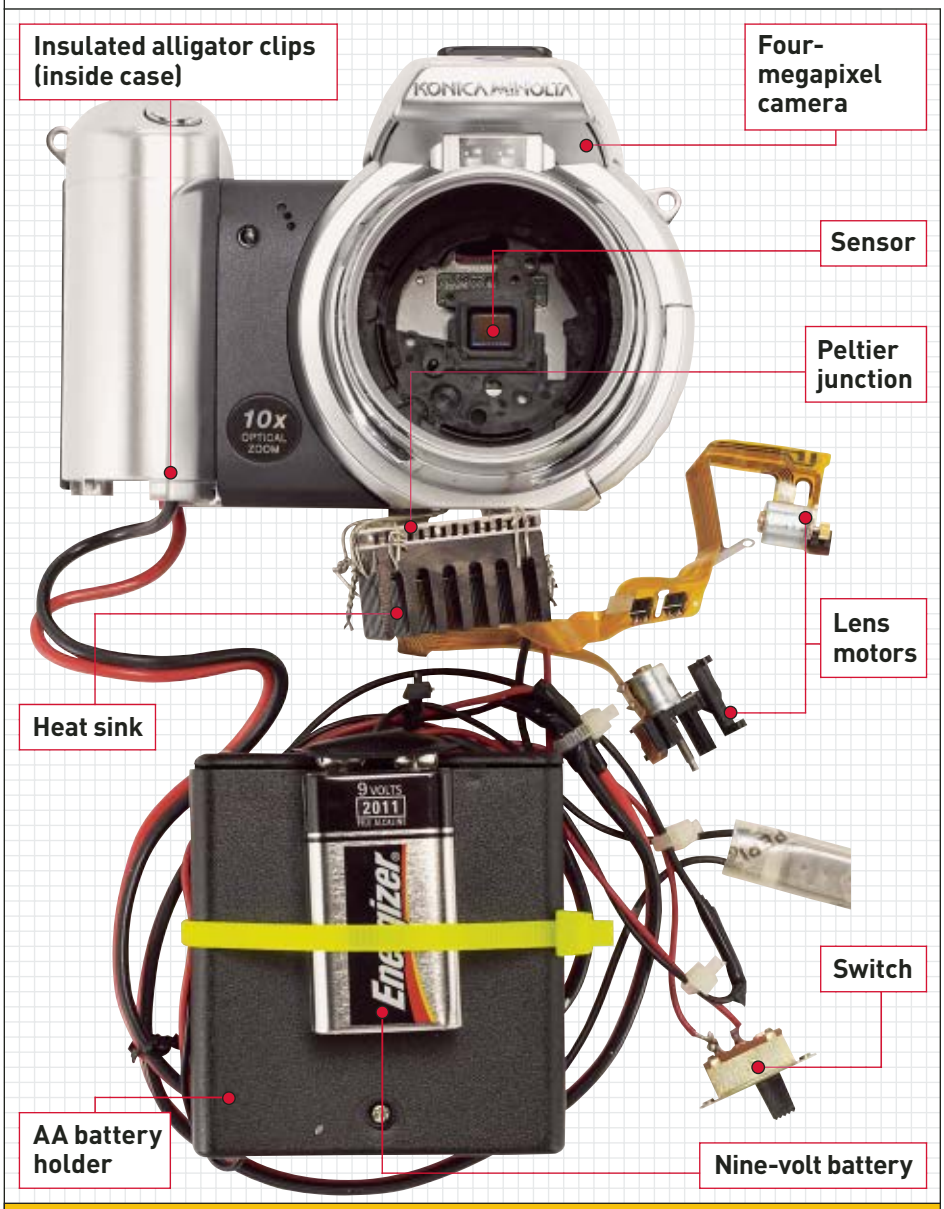
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REPURPOSED TECH

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Add a camera to your scope for cheap astrophotography

PROFESSIONAL-GRADE ASTRONOMY CAMERAS take great shots of the cosmos, but their prices can be, well, astronomical. Instead, attach that long-forgotten low-megapixel digital cam to your telescope—it contains the same basic type of sensor found in the high-end models: a charge-coupled device, or CCD. Of course, regular cameras aren't built for astrophotography; the batteries and circuitry build up heat, which creates stray pixels on the sensor that look like stars in photographs. But if you're willing to open your camera and make a few modifications, any digital with at least two megapixels can capture memorable Martian moments without the fake twinkles or the sky-high cost.—DAVE PROCHNOW



See *popsci.com* for detailed instructions and a parts list.

PHOTOGRAPHS: THIS PAGE: LUIS BRUNO; FACING PAGE: DAVE PROCHNOW

MAKE YOUR CAMERA SPACE-READY

16 HOURS	$18.37

EASY ▯▯▯▮▯ HARD

H2WHOA! Before opening any camera, remove its battery. Avoid touching the flash circuit, which stores a charge for an unpredictable length of time. Wear rubber gloves and rubber-soled shoes, and use insulated tools.

1. OPEN the camera by removing the screws holding the case together. Look for hidden screws under stickers and trim.

2. FIND and release all the cables and plugs, and then gently pull the case halves apart.

3. DISCONNECT and remove the lens assembly, but leave the ribbon cable attached to the motors.

4. ATTACH the heat sink and Peltier junction—a device that electronically draws heat away from whatever it's next to—directly to the back of the camera's circuit board with wire ties or, if it doesn't fit, externally below the circuit board.

5. RELOCATE the batteries to the outside of the camera to further reduce heat. Just run longer wires to the old leads.

6. REMOVE the infrared filter, a piece of glass in front of the CCD. Your shots will take on a slight pinkish tint but should be brighter.

7. REASSEMBLE the camera and slip its lens barrel over your telescope's eyepiece holder or focusing tube.



SHOOT THE MOON
The author's modified Konica takes nearly professional-grade pictures.

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ROM • MANUFACTURED IN CALIFORNIA SINCE 1990

TIME IS IT. Over 92% of people who own exercise equipment and 88% of people who own health club memberships do not exercise. A 4 minute complete workout is no longer hard to believe for all the people who since 1990 have bought our excellent Range of Motion machine (ROM). Over 97% of people who rent our ROM for 30 days wind up purchasing it based upon the health benefits experienced during that tryout, and the ROM performance score at the end of each 4 minute workout that tells the story of health and fitness improvement. At under 20 cents per use, the 4 minute ROM exercise is the least expensive full body complete exercise a person can do. How do we know that it is under 20 cents per use? Over 90% of ROM machines go to private homes, but we have a few that are in commercial use for over 12 years and they have endured over 80,000 uses each, without need of repair or overhaul. The ROM 4 minute workout is for people from 10 to over 100 years old and highly trained athletes as well. The ROM adapts its resistance every second during the workout to exactly match the user's ability to perform work. It balances blood sugar, and repairs bad backs and shoulders. Too good to be true? Get our free video and see for yourself. The best proof for us is that 97% of rentals become sales. Please visit our website at: **www.FastExercise.com**.

The typical ROM purchaser goes through several stages:

1. Total disbelief that the ROM can do all this in only 4 minutes.
2. Rhetorical (and sometimes hostile) questioning and ridicule.
3. Reading the ROM literature and reluctantly understanding it.
4. Taking a leap of faith and renting a ROM for 30 days.
5. Being highly impressed by the results and purchasing a ROM.
6. Becoming a ROM enthusiast and trying to persuade friends.
7. Being ignored and ridiculed by the friends who think you've lost your mind.
8. After a year of using the ROM your friends admiring your good shape.
9. You telling them (again) that you only exercise those 4 minutes per day.
10. Those friends reluctantly renting the ROM for a 30 day trial. Then the above cycle repeats from point 5 on down.

The more we tell people about the ROM the less they believe it.

From 4 minutes on the ROM you get the same results as from 20 to 45 minutes aerobic exercise (jogging, running, etc.) for cardio and respiratory benefits, plus 45 minutes weight training for muscle tone and strength, plus 20 minutes stretching exercise for limberness/flexibility.

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RENT A ROM FOR 30 DAYS. RENTAL APPLIES TO PURCHASE.



SQUEEZE BOX Chumby's cuddly casing belies its power and hackability.

USE IT BETTER

ANYTHING YOU WANT IN A GADGET

Meet Chumby, an open-source touchscreen Internet device that's so customizable (and so soft), you'll want to spend your whole day with it

YOU PAY BIG BUCKS for your devices, so why shouldn't you decide what they do? That's the question behind Chumby ($150; *chumby.com*), a wireless Internet box developed by a group of hackers weary of traditional electronics design—bland, square gadgets like MP3 players restricted to a few prescribed functions. Powered by a 266-megahertz processor, 32 megabytes of flash memory (with an upgrade on the way) and open-source software, Chumby is instead a platform with the capacity to do pretty much anything its users decide it should. If, say, you want regular injury reports for your fantasy baseball team, a reminder to TiVo the *Beverly Hillbillies* marathon, and status updates on your eBay auctions, you can create Chumby "widgets" to do the work, or download existing ones off the Web. And Chumby's makers encourage you to hack the bugger for any function—home automation, GPS—you can dream up. But even if you don't care to change Chumby on the inside, you can always do it on the outside; its squeezable, soft suede casing is just as ready to mod as its guts.—DOUG CANTOR

CHUMBIFY YOUR LIFE

$150

EASY ▮▯▯▯▯ HARD

1. Squeeze the sensor on the top right to get the control-panel screen. Select "settings" on the touchscreen, choose the "network" button, and let Chumby find a wireless connection.

2. Log on to *chumby.com* to give your Chumby a name (ours is called "Poppy"). Then click the "edit default widgets" link to browse through the list of available widgets, and click on any you want to add.

3. Allow about 10 minutes for your Chumby to be updated with the new widgets you selected. For instructions on creating your own widgets and hacking the Chumby, go to the site's "developers" section.

A DAY'S WORTH OF USES FOR YOUR CHUMBY



7:10 A.M. Wake up to Chumby's alarm clock.



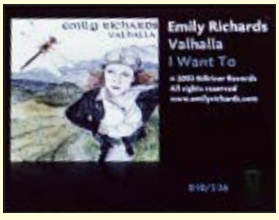
8:22 A.M. Get the forecast before walking Fido.



12:45 P.M. See how your stocks are doing.



5:43 P.M. Preview your commute on a webcam.



11:04 P.M. Fall asleep to some downloaded music.

JOHN B. CARNETT





Watering chores, water bills! Sweating behind a roaring mower! Spraying poison chemicals and digging weeds...





...you can end such lawn drudgery – here's how!



Amazoy is the Trade Mark registered U.S. Patent Office for our Meyer Zoysia Grass.

Mow your zoysia lawn once a month – or less! It rewards you with weed-free beauty all summer long.

7 Ways Your Zoysia Grass Lawn Saves You Time, Work, and Money!

1 CUTS WATER BILLS AND MOWING AS MUCH AS 2/3

Would you believe a lawn could be perfect when watered just once? In Iowa, the state's biggest Men's Garden club picked a zoysia lawn as "top lawn – nearly perfect." Yet, this lawn had been watered only once all summer to August!

In PA, Mrs. M.R. Mitter wrote "I've never watered it, only when I put the plugs in...Last summer we had it mowed 2 times...When everybody's lawns here are brown from drought, ours stays as green as ever." *That's how zoysia lawns cut water bills and mowing! Now read on!*

2 ENDS RE-SEEDING NEVER NEEDS REPLACEMENT

Plug in our zoysia grass and you'll never have to spend money on grass seed again! Since you won't be buying seeds, you won't need to dig and rake – then hope the seeds take root before birds eat them or the next hard rain washes them away.

3 NO NEED TO DIG UP OLD GRASS

Plant Amazoy in old lawn, new ground, whatever. Set 1" square plugs into holes in the soil 1 foot apart, checkerboard style. Plugs spread to drive out old, unwanted growth, weeds included. Easy instructions with your order. If you can put a cork into a bottle, you can plug in Amazoy.

4 FOR SLOPES, PLAY AREAS, AND BARE SPOTS

You can't beat Amazoy as the low cost answer for hard-to-cover spots, play-worn areas, or to end erosion on slopes.

5 IT STAYS GREEN IN SPITE OF HEAT AND DROUGHT

"The hotter it gets, the better it grows!" Plug-in zoysia thrives in blistering heat, yet it won't winter kill to 30° below zero. It just goes off its green color after killing frosts, begins regaining its green color as temps. in the spring are consistently warm. Of course, this varies with climate.



Thrives from part shade to full sun.

Every Plug GUARANTEED TO GROW IN YOUR SOIL *No Ifs, Ands Or Buts!*

Read a guarantee no grass seed can match!

Won't Winter Kill. Amazoy has survived temperatures to 30° below zero!

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Any plug failing to grow in 45 days will be replaced FREE! To insure maximum freshness and viability, plugs are shipped not cut all the way through. Before planting, finish the separation with shears or knife. Our guarantee and planting method are your assurance of lawn success backed by more than five decades of specialized lawn experience!

6 CHOKES OUT CRABGRASS AND WEEDS ALL SUMMER

Your established Amazoy lawn grows so thick, it simply stops crabgrass and summer weeds from germinating!

7 NO NEED TO SPEND MONEY ON DANGEROUS CHEMICALS

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❑ 2 Basic Packs + 1 FREE	200	100	–	*$ 23.85*	$15.90	$ 5.00	30%
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❑ 5 Basic Packs + 3 FREE	500	300	Free Step-on Plugger	*$ 72.55*	$39.75	$10.00	42%
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❑ 9 Basic Packs + 7 FREE	900	700	Free Power Plugger	*$ 152.15*	$71.55	$15.00	50%
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❑ Extra Step-on Plugger $8.95 ❑ Extra Power Plugger for 3/8" Drill $24.95

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As a member of the community of jewelers, I have the opportunity to frequently visit Antwerp, Belgium, the Diamond Capitol of the World. All of the most renowned jewelers buy their best diamonds here. My 5th generation Belgium gem broker is at the top of his trade and enjoys finding a special gem with a certain size, shape, color and clarity—he doesn't trade in what is available on the local market. Recently he was excited to discover a hoard of the most sought after diamonds today: Canary and Fancy Yellow diamonds. Many people find yellow diamonds more desirable than any other color due to their inherently warm optic color.

During our visit, he proudly displayed a brilliant round-cut Canary diamond, explaining that natural yellow color diamonds are 10,000 times more rare than their brilliant white, colorless counterparts. Turning the stone in the light, he said the intensity of color is of paramount importance, and clarity increases the inherent value of a high-quality color diamond. He said this fine Canary Yellow gemstone, framed by two white diamonds, should retail for at least $10,000. As my broker admired this treasure, I decided now was the time for a little amusement.



Our Natural Mined Canary Ring

Fancy Yellow Round-Cut Diamond (.67 carats):
Natural yellow color
Clarity rating: VS

Two Companion White Round-Cut Diamonds (.49 total carats):
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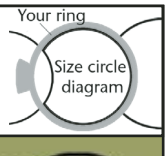
Setting: Platinum and 18K gold

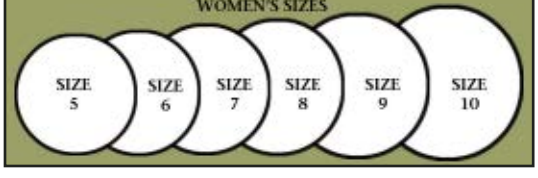
As he glanced away, I placed a similarly colored lab-created Diamond*Aura* yellow stone next to the natural mined diamond. My broker thought he was seeing double. I asked him to choose the mined diamond, but he said he could only guess. After close examination he was astonished—the faultless, lab-created stone was so visually similar in almost every way! He started to wonder about the future of the diamond business.

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Bring the beauty of a radiant sunrise to your own collection. If your ship has already come in, we will gladly sell you the ring with the natural mined Canary Yellow diamond at a cost of $10,000. But the labs at Diamond*Aura* give you a more affordable option at **only $149.85**. The choice is yours! Wear the Diamond*Aura* Canary Ring for 30 days. If for any reason you are not satisfied with your Diamond*Aura* purchase, or you experience any defects in these faultless, lab-created stones, simply return them to us for a full refund of the purchase price.

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ASK A GEEK

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For either, try to contact the owner of the site or the person responsible for its content and ask them to take it down. When it's a document or photo you created that's somehow migrated out of your control, try citing copyright law, which prevents others from posting your content without your permission. Many sites list a procedure for removing this type of material.

One way to keep a low profile from the start is to use a free tool like *fakenamegenerator.com*, which creates generic usernames, passwords and other information you can use to register on Web sites.

LAUREN GELMAN is the associate director of Stanford Law School's Center for Internet and Society.

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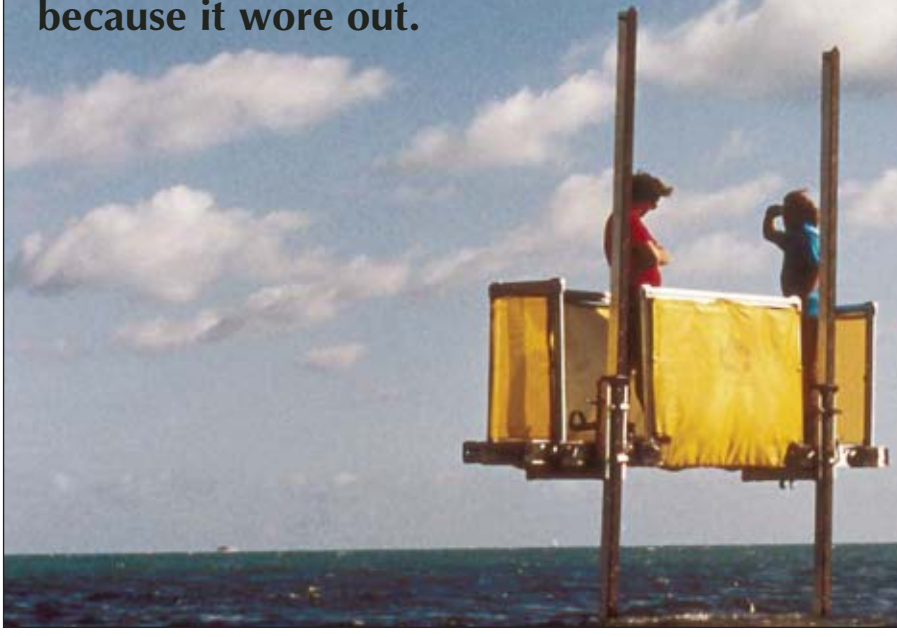
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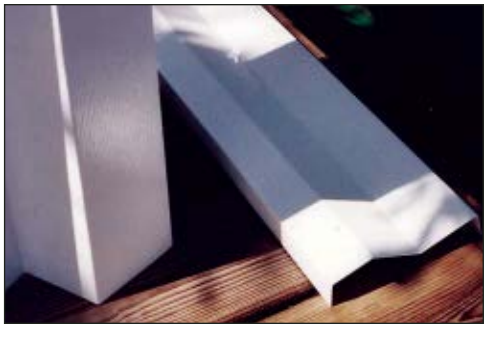
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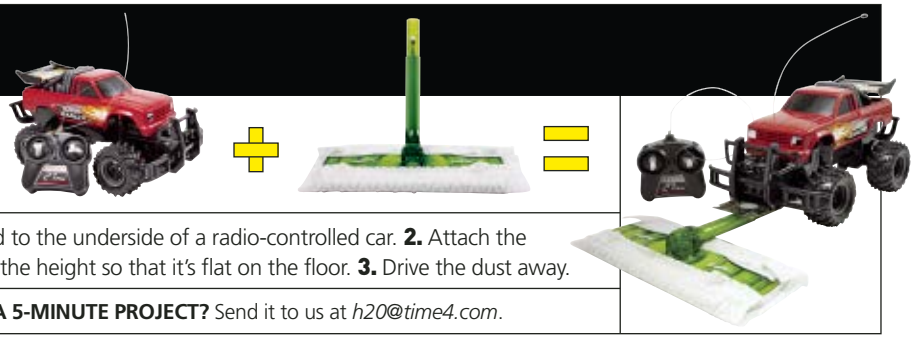
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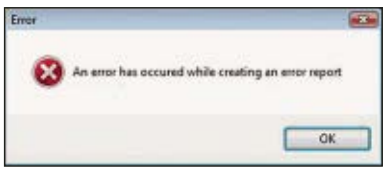


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*Originally posted on *evilmadscientist.com*.

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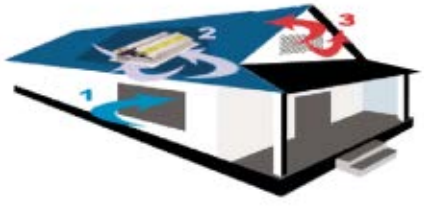



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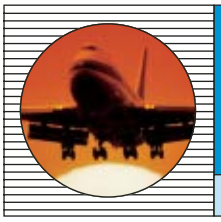
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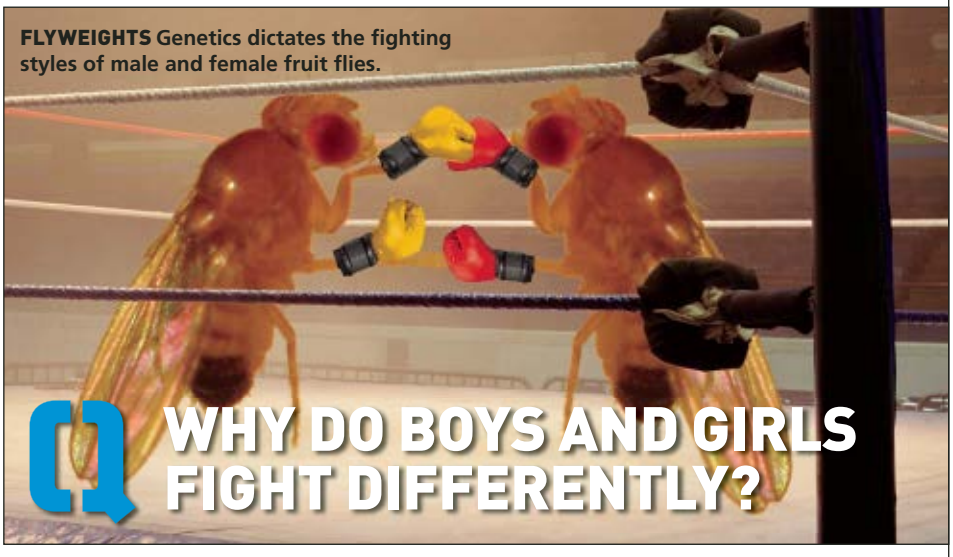
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FYI

SOMETIMES YOU JUST NEED TO KNOW



FLYWEIGHTS Genetics dictates the fighting styles of male and female fruit flies.

Q WHY DO BOYS AND GIRLS FIGHT DIFFERENTLY?

A Science is still some way from explaining why boys throw punches and girls pull hair on the playground. In the boxing ring, though, it's making progress—at least when the combatants are fruit flies.

Edward Kravitz, a professor of neurobiology at Harvard Medical School and the Don King of fly fights, has identified a gene that controls the fighting tactics of male and female fruit flies. To instigate the same-sex battles, Kravitz offers lavish prizes: yeast for the females and, for the males, the privilege of courting a headless female. "We won't get into social commentary with that fact," he jokes.

As you might expect, the males fight fiercely. They lunge and then rear up to drop blows with their forelegs. "If you watch in slow motion, they just flatten their opponent," Kravitz says. Females choose to shove and head-butt, a daintier but equally effective approach.

But are the different fighting styles learned behavior, or are they hardwired in the flies' DNA? To find out, Kravitz transplanted the male version of a gene previously associated with gender-specific behaviors, such as male courtship, into females and put the female version in males. After the gene swapping, the males fought like females and the females adopted male techniques, providing the first evidence of gene-controlled gender-specific aggression in fruit flies.

Kravitz's research doesn't translate smoothly to humans, however, because we don't have a gene corresponding to the one he swapped in flies. Also, scientists generally agree that different levels of testosterone exposure early in life are probably responsible for the aggression-related gender variation in humans. But Kravitz thinks his finding will help neurobiologists understand how complex behaviors like aggression get wired into the nervous system—without anyone getting pummeled in the ring.

—MICHAEL ROSENWALD

Q I paid an extra $17 to make my cross-country flight "carbon-neutral." Am I saving the planet, or am I a sucker?

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HERMAN EISENBEISS/PHOTO RESEARCHERS (FLY); LEW ROBERTSON/CORBIS (GLOVES); S. MELTZER/PHOTOLINK/GETTY IMAGES (BOXING RING)



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are now making carbon neutrality part of their brand identity, offsetting their emissions by funding such projects as building wind farms in Nebraska, providing solar panels to Africa, and planting mango trees in India.

Dozens of companies will gladly take your money to help assuage your global-warming guilt. According to the Environmental Protection Agency, the average American generates 10 tons of carbon dioxide annually, which most companies estimate can be offset for $100 to $200. Last August, the online travel services Expedia and Travelocity began offering customers the option of canceling out the CO_2 resulting from their purchased travel ($17 for a round-trip coast-to-coast flight on Expedia; $10 on Travelocity).

But is it all a scam? Not necessarily. The key is to make sure your money is funding projects that actually do prevent emissions and that reduce them beyond what would be achieved by business as usual, a concept known in the industry as "additionality." One organization that educates consumers on which programs measure up is the nonprofit Clean Air–Cool Planet (*cleanair-coolplanet.org*). Last December, it released a comprehensive evaluation of offset providers, rating each on a scale of 1 to 10. Of 30 companies evaluated, only eight earned a 5 or higher.

Meanwhile, the European watchdog group Gold Standard Foundation (*cdmgoldstandard.org*) certifies well-run, legitimate carbon-offsetting projects using a system that works much like the "fair trade" coffee and "100% organic" labels. "Beware of any old company claiming to be carbon-neutral," says marketing director Jasmine Hyman. "It's the wild, wild West."

Bottom line: Instead of paying an intermediary to offset your emissions, make a contribution directly to a well-reviewed organization (Atmosfair and NativeEnergy are two good bets). And remember, the best way to guarantee that your personal emissions will be reduced is to reduce them yourself. Money's not enough, something Coldplay found out the hard way. The mango trees in India that they funded died due to a lack of maintenance.—KALEE THOMPSON



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Professor John J. Renton says that predictions of the inevitable decrease and disappearance of worldwide oil supplies appear all too accurate. On the other hand, he notes, "Coal is to the United States what oil is to Saudi Arabia. We have more coal than anybody in the world." While other options certainly will be pursued, coal seems destined to play an increasingly important role in America's energy economy.

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In this course you will also learn: how to recognize a killer volcano, what structures are safe in an earthquake zone, and why you may need to add lime to your lawn every year for your grass to flourish—depending where you live.

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You will delve deeply into the theory of plate tectonics, a beautiful idea that explains why mountains, earthquakes, volcanoes, and other natural phenomena occur where they do. Professor Renton describes plate tectonics as "the most significant contribution to the science of geology in its 250-year history."

Like many geologists, Dr. Renton is plainspoken, no-nonsense, rugged, and with a tinge of romanticism. He is also an award-winning educator with more than 40 years of experience teaching introductory geology at West Virginia University. You will find him spontaneous, easy to follow, funny, and extremely well organized.

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(CONTINUED FROM PAGE 71)

THE MEMORY HACKER

cells are less than 15 years away.

Unsurprisingly, Berger's ambitions for the brain tend to court controversy. The misty realm of cognition, the part of us that receives and remembers knowledge, has long seemed impossible to reproduce in the lab. What makes humans unique, after all, is the fact that no two of us think alike—the result of individual patterns of associations, personal memories and thought processes that inherently defy machine-like standardization.

That's why the notion of a "bionic brain" puts off so many observers of Berger's work. Tampering with fundamental processes like memory and consciousness could play havoc with notions of identity. For instance, what if a brain chip of the future caused people to recollect things that never happened to them? Or what if it destroyed healthy memories to make room for new ones? "We could be screwing up good memories as well," Granacki admits.

Walt O. Schalick, a physician and the associate director of the Center for the Study of Ethics and Human Values at Washington University in St. Louis, echoes that concern, asserting that a chip like Berger's could fundamentally alter one's identity. Changing the wiring of our memories, he warns, could subtly scramble our patterns of association and, by implication, the "thought structure" that defines our individual personalities. This could happen, he argues, principally because even the best model of hippocampal cells doesn't tell us everything about how the brain is working. "Modeling or even mimicking is not replacing," Schalick says. "Dr. Berger's experiments at this stage offer only an incomplete bridge."

He points to conceptions of how the heart worked in the early 20th century, when most people assumed it was nothing more than a pump. Then they discovered it was also an endocrine organ, and decades of work had to be done to adjust our grasp of its processes. "Those who view this work as a step toward an uploadable brain—put in a new SD card with your Calculus 1 information, and take the test—are a long way off," he says.

Another problem is that researchers have found that damage from diseases like Alzheimer's occurs in many places in the brain. Fixing one broken slice of brain circuit, therefore, may not be enough. "It's important to remain skeptical," Dartmouth's Granger says. "We may make something that looks like an arm, but it can't pick up a cup of coffee."

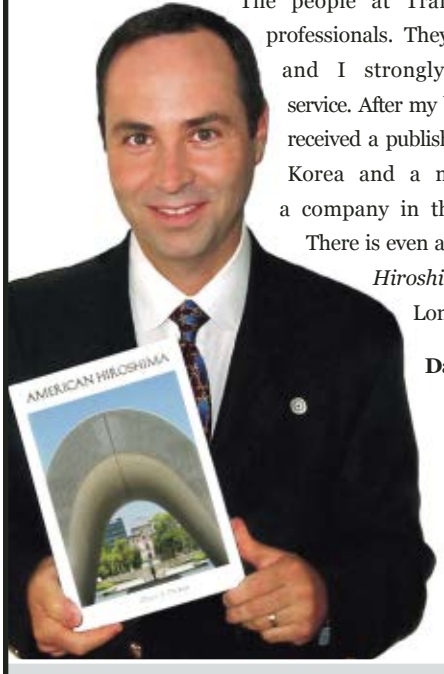
DINING WITH DOCTORS

Although the ethical implications of Berger's work are significant, there is

(CONTINUED ON PAGE 100)

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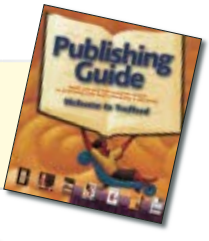


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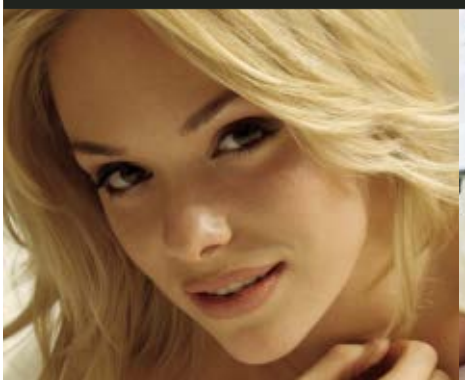
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Jason M.
Manhattan Beach, CA

A: Well Jason,

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For months my fiancé was feeling the exact same way you were and then, one night, we had the most phenomenal sex, EVER. I had never seen him more excited and powerful. He took control right from the start and the feelings we shared together were totally mind-blowing. And, here's the best part, every time since that night, he just keeps getting better and better. It's amazing! I can't get enough of him now!

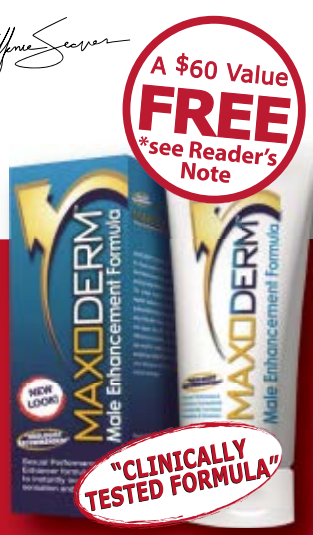
Finally, the other day, my curiosity took over. I had to know what brought about this drastic change. So, I asked him. To my shock, he handed me a tube of Maxoderm. I just couldn't believe this product Maxoderm was actually making him feel fuller, harder and way more vigorous. I did a little research and was surprised by what I found.

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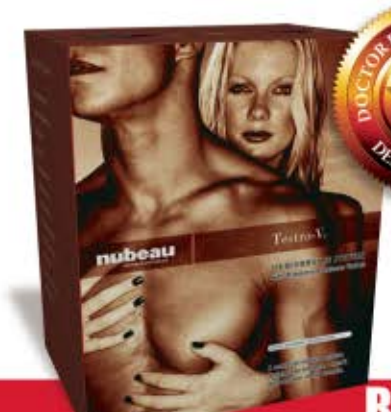
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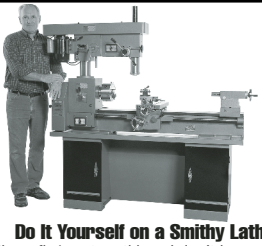


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(CONTINUED FROM PAGE 96)

THE MEMORY HACKER

no shortage of people willing to fund it. The National Science Foundation and the National Institutes of Health contribute to the annual $3-million research budget for Berger's project. So do the Pentagon's Office of Naval Research and the Defense Advanced Research Projects Agency, the Pentagon's experimental-technologies arm. Brain-machine interface research holds obvious potential for tomorrow's soldiers: Think of mini chips attached to a combat grunt that could provide infrared night vision, for instance.

Meanwhile Berger's research, once the stuff of fantasy, is already finding its way into the mainstream. In 2003 Berger formed Safety Dynamics, a company in Tuscon, Arizona, that applied his neural-modeling techniques to develop an acoustic-recognition system called the Sentri. It can distinguish the noise of a gunshot from, for example, the sound of a misfiring car cylinder—a handy way for short-staffed police forces to monitor crime-plagued neighborhoods. Police departments in Chicago and in Tijuana, Mexico, now employ the device, and authorities in Phoenix, Los Angeles and Oklahoma City have expressed interest in it.

Yet we are still years away, possibly decades, from getting ourselves fitted for a personal memory upgrade. But, Granger says, "it's time to take the idea seriously."

Berger drops me off at the USC campus. He's headed to another conference in the morning, this one in Paris. Although it's satisfying to be in demand, Berger says he misses the days of tinkering in the lab. "Sometimes I'd like to just go back to pure research," he admits. "But it's nice to see it start to pay off."

I ask Berger about his plans for the evening. He's headed to his hilltop home on the Palos Verdes peninsula overlooking the Pacific. "I promised my daughter, Kimberly, and my wife that I'd be home early for once," he says, and I nod, imagining talk of homework and PTA meetings. But I'm wrong. Berger's wife, Roberta Brinton, is a leading USC researcher on estrogen-replacement therapies in Alzheimer's patients and has worked as part of Berger's team to culture living brain cells onto silicon chips. Suddenly the man's energy and determination snap into focus for me: He unwinds from being a jet-setting brain scientist by going home—and talking about the brain. "We discuss prosthetics over dinner," he acknowledges with a shrug, and turns to his car.

Stephen Handelman is a freelance writer in New York. He wrote about homeland-security tech in the September 2006 issue.

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By Matt Furey
Best-selling author of *Combat Conditioning*

I was the total skeptic. Not only had I lifted weights and run long distance for years, but I had major success under my belt, including a world kung fu championship and a national collegiate wrestling title.

So I just didn't want to believe what Karl, a 76-year old man told me about exercising WITHOUT weights… and WITHOUT long-distance running.

Most importantly, I didn't want to hear that a good exercise program only took a few minutes. Hate to admit it, but I was addicted to the "hard work or nothing" mentality and refused to believe you could get into the best shape of your life by doing LESS… not more.

Let me tell you, when I looked at this so-called "old man's" physique and watched him demonstrate his exercises, I could not look the other way. I had to check them out for myself, even if it meant saying, "Okay, I've wasted a lot of time doing it the wrong way."

What I discovered shocked me from head to toe!

Before I met Karl I THOUGHT I was strong. I thought I was tough. But the exercises he gave me exploited every weakness that weights and running could not cover, In a matter of minutes, I knew Karl "had me."

So I gave up the weights and began a routine of bodyweight calisthenics called *Combat Conditioning*. Afterall, when a man of 76 can do things that a 36-year old cannot do, that tells you that "Yes, there's gold in them there hills."

The exercises I learned had such a profound and dramatic effect on me, that for six years I have been introducing men and women of all ages and of all backgrounds to this extraordinary program – and the results are shocking, awe-inspiring and PROOF that this system works, and works FAST.

Who is Combat Conditioning for?

It's for the hard-working man or woman who often finds it difficult to squeeze in a quick workout.
It's for the traveling executive who sleeps in hotel rooms more than at home.
It's for those who have trained their whole lives on weights.
It's for athletes, martial artists and the military.
And .. **IT'S FOR** the man or woman who hasn't done a lick of exercise in decades.

Even One Minute a Day Brings Results!

Unlike other exercise program where you are told you **MUST** do 30 minutes of cardio per day and an hour of weights, to get results, *Combat Conditioning* is totally different. 15 minutes is all it takes to whoop the hard-core trainee. But for the total beginner, he or she can get results starting with ONLY one minute a day. And no, this is not a joke.

Time is not the issue!

Forget all those workouts that take all day. With *Combat Conditioning*, all that's required is your own body and a tiny "get started NOW" decision to DO a little something each day.

The key to your success is in the magical, transformative power of these exercises – not in your belief system about hard work. For many people, just one rep is all they can do at first, and they're shaking like a leaf on a windy day in Chicago. And so, that's all that person should do at first. Even if you think you're not doing enough – the exercises work their magic anyway. Your body has it's own intelligence and will work FOR YOU if you'll simply get out of the way and let it.

When you do, pretty soon you'll be the type of person who can do 2, 4, 8, 16, 32, 64 or 128 repetitions and feel no fatigue. Instead of tiredness you'll feel exhilaration and ENERGY. You're building strength and endurance from the INSIDE-OUT. And believe me, once you can do more than a few reps, inches of unsightly fat and pounds of excess flab will fly off your body at break-neck speed.

New Results from Forgotten Exercises

Are the exercises in *Combat Conditioning* NEW? Well, not really. They go back about 5,000 years – but for the most part, they got lost in the shuffle when weights, gadgets and gyms came around. So although they aren't NEW, they're "New to YOU!"

Before I learned these exercises, I read about the Great Gama of India, a wrestler who followed this program and was unbeaten in 5,000 matches. I also read that the legendary Bruce Lee did these exercises, too. And we all know about Lee's incredible martial arts skills. Then there was the All-Pro NFL running back, Hershell Walker, who did bodyweight exercises each day. The list goes on and on. The key is in having a proven program with a track record, and *Combat Conditioning* is just that.

Puts You into the Old Clothes You Dream of Wearing Again!

The main reason why *Combat Conditioning* works is because it targets all the weak links in your body. And when all those weak links are given a little attention, your entire body gets stronger, faster, more powerful and more energetic. Spend time each day doing a few functional exercises and the payoff is HUGE.

You get functional strength, endurance and flexibility – all at the same time. Not to mention seeing the excess inches flying off your body, making it easy for you to fit into the clothes you dream of wearing again. Stop dreaming. Start DOING. And get results.

12 Ways Combat Conditioning Will Change Your Life!

Follow this program and your body is going to change big time. In fact, I've made a list of 12 of the most powerful benefits that hundreds of thousands of others all over the world have gotten from the *Combat Conditioning* program. Let's take a look:

1. **Cranks up your metabolism so you burn excess body fat a lot, lot faster. This means fitting into the clothes you WANT to wear.**
2. Packs attractive and healthy functional muscles (not grotesque) onto your entire body
3. **Simultaneously doubles your strength and flexibility – and does so without needing separate workouts for each.**
4. Quadruples your endurance inside of 30 days. Never get tired again.
5. **Within a couple weeks, it often eliminates chronic back and shoulder pain from years of heavy squats, deadlifts and bench pressing – or other forms of abuse.**
6. Sleep like a log. Eight hours of deep sleep is no longer a goal. It's automatic. As soon as you hit the rack you're out like a light.
7. **Your self-confidence will have no bounds. Especially when you got compliments from people who hardly paid attention to you before.**
8. You can train anywhere. You don't need more than a few square feet of carpet or pavement and you're all set. You don't need equipment. Just your own bodyweight.
9. **You get a kick-butt workout done in 15 minutes or less.**
10. You'll turn back the clock. Friends may tell you that you look 5–10 years younger.
11. **You'll have an explosive type of strength that weights cannot give you. Your every movement will be lively and full of vigor.**
12. Your muscles will be pliable and powerful, like a tiger's.

Here's How to Order

Combat Conditioning: Functional Exercises for Fitness has 48 super effective bodyweight exercises along with seven different programs that will get you into kick-butt shape fast. Order NOW and you'll receive 3 free Special Reports on how to eliminate knee, back and shoulder pain. Your total investment in this no-nonsense book is only $29.95 plus $6 S&H U.S. (foreign orders add $12). Order online at www.mattfurey.com.

Or pick up the phone right now and call 1 813 994 8267 to order. You can also send a money order to Matt Furey Enterprises, Inc., 10339 Birdwatch Drive, Tampa, FL, 33647.



Matt Furey won a national collegiate wrestling title in 1985 and a world shuai-chiao kung fu championship in 1997. Furey has a knack for taking the average and ordinary person and transforming him with his powerful programs. Furey was inducted into the Edinboro University Athletic Hall of Fame in 1998 and spends much time each year traveling throughout the world, searching for the very best information available to his world-wide audience. His website, **www.mattfurey.com**, is one of the finest in the world, giving valuable information that changes lives.

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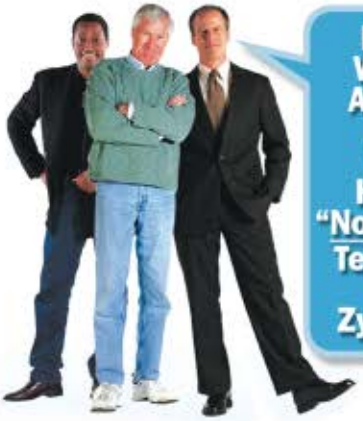
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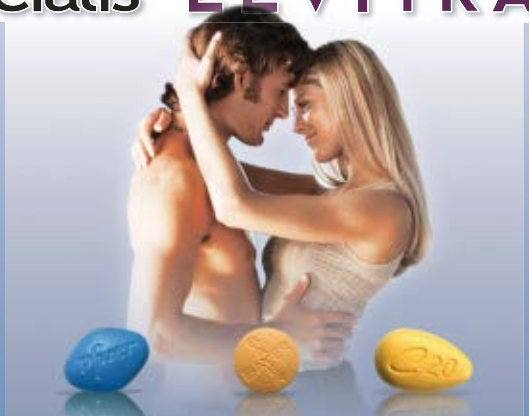
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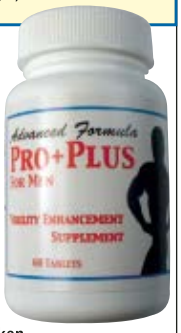
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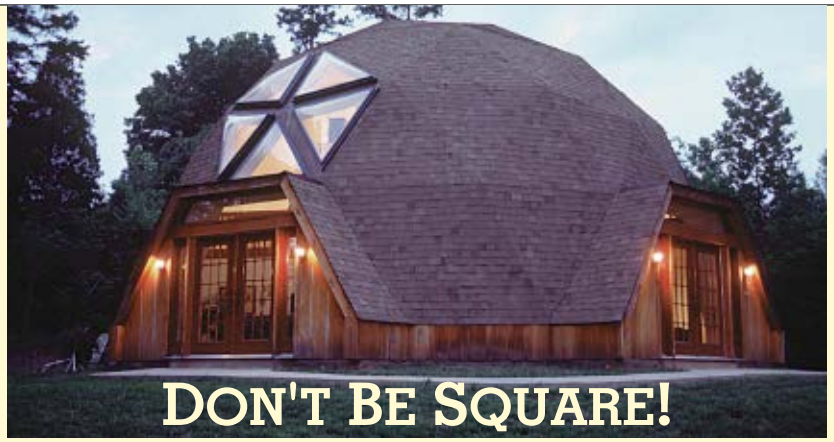
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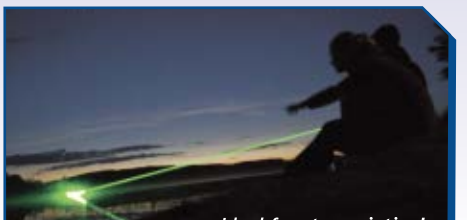
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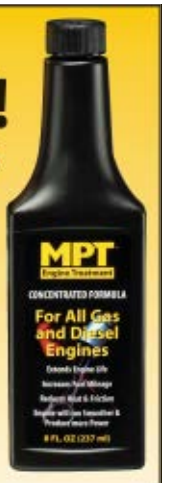


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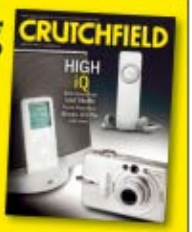


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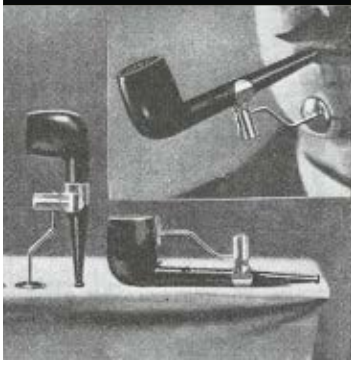
The Gold Digger

An early submarine was on a quest for buried treasure

We called it a "veritable one-man submarine of steel." This craft was developed specifically to search for $3 million worth of gold nuggets rumored to lay buried within the wreck of the S.S. *Islander,* a ship that sank in 1901 after striking an iceberg off the Alaskan coast. The sub, tethered to a surface ship, withstood depths of up to 365 feet; its arm was designed to grasp any booty it encountered once it was down there. Unfortunately, the sub recovered only a tiny amount of gold (the bulk of the treasure, which was hidden in the ship's bow, was finally found in 1996), but the technology was a harbinger of things to come. For a look at one of today's most advanced deep-sea diggers, see "The Cable Monster" on page 54.—KATHERINE RYDER



OTHER STORIES FROM THE SEPTEMBER 1931 ISSUE



SMOKING MADE EASIER

The headline said it all: "Suction Cup on Chin Holds Smoker's Pipe." Made in England, this odd contraption was nothing if not versatile. As we noted, "the holder also serves as a stand for the pipe and can be folded to carry pipe in pocket." How dashing.

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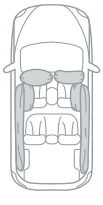
The first criminal fingerprint was taken in 1892 in Argentina. For years, the identification tool was used primarily to keep track of the bad guys, but by 1931 it had extended to some businesses—and the government. "All appointees to the Federal Civil Service are now fingerprinted," we wrote, "and the prints are attached to the application papers and retained permanently in the Civil Service files."

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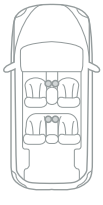
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